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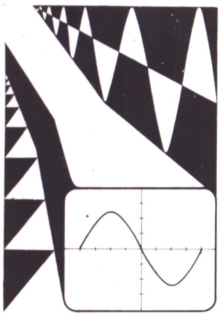

15MHz Dual-channel oscilloscope

PM 3211
PM3211Q

9499 440 19202

780801/1/02 e.v.

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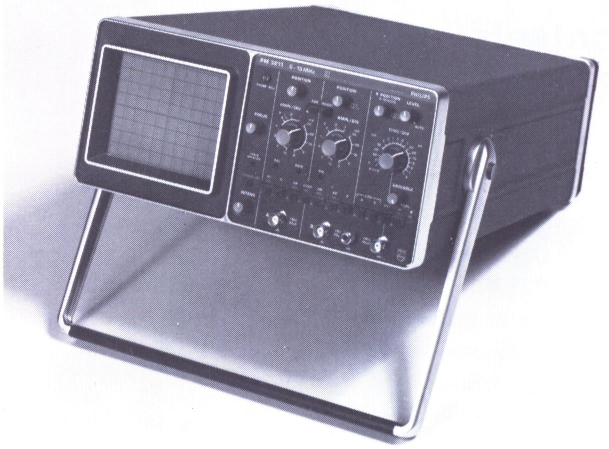

Instruction manual
Gerätehandbuch
Notice d'emploi et d'entretien

15 MHz Dual-channel oscilloscope
15 MHz Zweikanal Oszillograf
Oscilloscope 15 MHz à double trace

PM3211
PM3211Q

This documentation replaces:

9499 440 17802
9499 448 08911
9499 440 18511

9499 440 19202

780801/1/02 e.v.

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PRINTED IN THE NETHERLANDS

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Operating manual

1. General information

1.1. INTRODUCTION

The PM 3211 oscilloscope is a compact, lightweight instrument featuring ergonomic design and extensive measurement capabilities. It has a wide range of use which includes servicing, research and educational applications.

The instrument has a high sensitivity of 2 mV/DIV, a bandwidth of 15 MHz and a large 8 x 10 cm screen with a high intensity trace.
There is a wide choice of display possibilities enabling the choice of one channel, two channels in the alternate or chopped mode or both channels added. Channel B can be displayed in the normal or inverted mode.

The instrument has several trigger modes including TV triggering.

A double-insulated power supply allows the frame ground to be directly connected to floating ground circuits privided this ground does not carry live potentials.
Interference by ground currents, as is frequently experienced with grounded oscilloscopes is also substantially reduced.

The PM 3211Q is the USA-version of the basic PM 3211. In addition to the basic instrument the PM 3211Q is supplied with two 10:1 probes PM 9326/40.

Warning: The frame ground (and the probe's ground lead) must not be connected to live potentials.

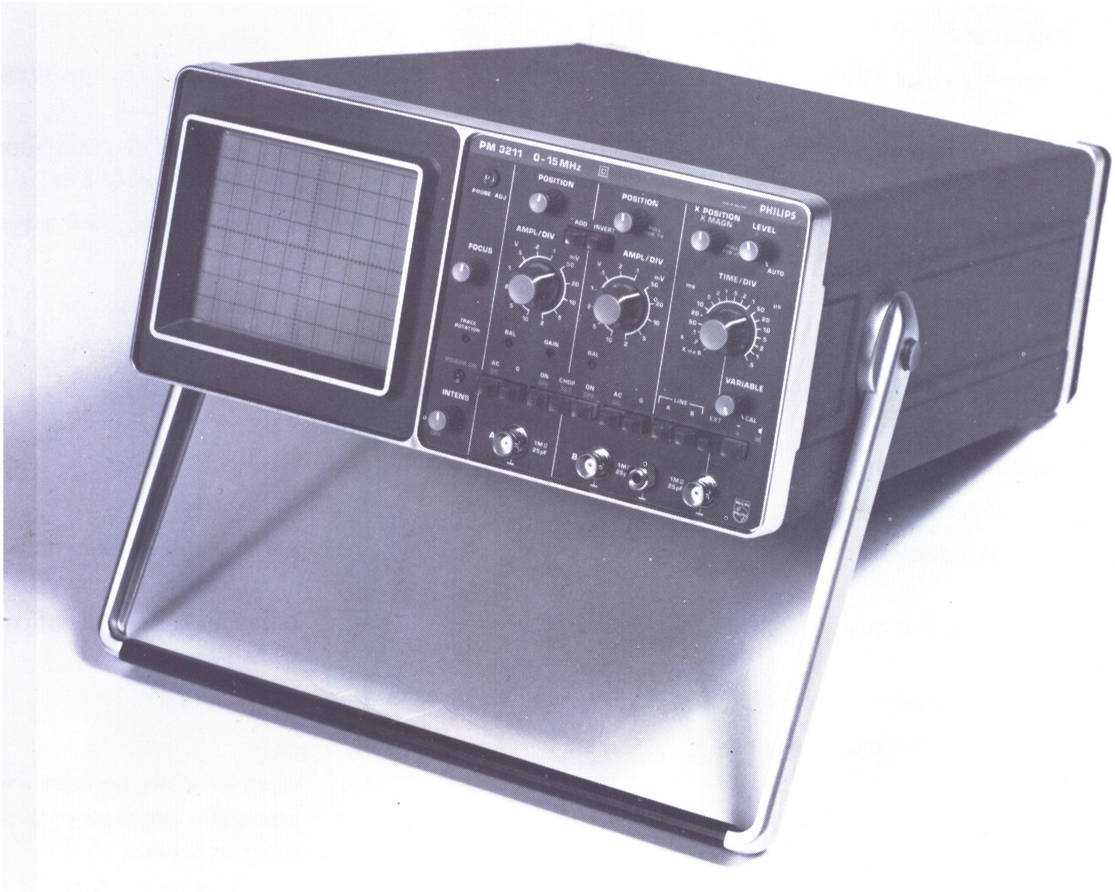


Fig. 1.1. 15 MHz dual-channel oscilloscope PM 3211

1.2. CHARACTERISTICS

This instrument has been designed and tested according to IEC Publication 348 for Class II instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition. Properties expressed in numerical values with stated tolerances are guaranteed for ambient temperatures of +5 °C ... +40 °C unless stated otherwise. Numerical values without tolerances are typical and represent the characteristics of an average instrument.

	Designation	*Specification*	*Additional Information*
1.2.1.	**C.R.T.**		
	Type	D14-260GH	
	Measuring area	8 x 10 divisions	1 div. equals 1 cm
	Screen type	P31 (GH) standard	P7 (GM) optional
	Total acceleration voltage	4 kV	
	Graticule	External	
1.2.2.	**Vertical amplifier**		
	Display modes	Channel A only Channel B only A and B chopped A and B alternated A and B added	
	Input coupling	AC, DC, 0	
	Channel B polarity	Normal or inverted	
	Response:		
	Frequency range	DC: 0 ... 15 MHz (−3 dB) AC: 10 Hz ... 15 MHz (−3 dB)	Measured at 6 div. amplitude
	Pulse aberrations	$\leqslant \pm 3$ %	Measured at 6 div. amplitude, applied rise time $\geqslant 3$ ns
	Deflection coefficients	2 mV/DIV ... 10 V/DIV	Calibrated steps, 1-2-5 sequence
	Deflection accuracy	± 3 %	
	Input impedance	1 MΩ/25 pF	
	Input RC time	22 ms	Coupling switch to AC
	Maximum permissible input voltage	400 V, DC + AC peak	
	Chopping frequency	250 kHz approx.	
	Vertical positioning range	± 8 DIV	
	Maximal deflection	24 DIV	For sinewave signals with frequencies up to 5 MHz
	C.M.R.R. in A-B mode	100:1 at 1 MHz	A-B mode with 8 DIV of common-mode signal
	Cross-talk between channels	−50 dB or better at 15 MHz	
	Instability of the spot position:		
	Trace jump	$<$ 0,3 DIV	When switching between any of the attenuator positions or operating other switches.
	DC stability	$<$ 1 DIV/hour	Over total temp. range

1.2.3. Time-base

Designation	*Specification*	*Additional Information*
Time coefficients	0,2 s/DIV ... 0,5 µs/DIV	1-2-5 sequence
Continuous control range	1:⩾ 2,5	Uncalibrated continuous control between the 1-2-5 steps
Coefficient error	± 3 %	
Magnification	5x	
Additional error for magnifier	± 2 %	

1.2.4. Triggering

Source	Ch. A, Ch. B, External input and line/mains	
Coupling	AC	
Trigger mode	Automatic or Normal	Automatic mode combined with top level mode
Trigger sensitivity	Internal: 0,75 DIV 1,5 DIV External: 0,8 V	Signals ⩽ 5 MHz Signals ⩽ 15 MHz Signals ⩽ 15 MHz
Triggering frequency range	20 Hz ... 15 MHz 10 Hz ... 15 MHz	Automatic free run Normal
Level range	Internal: ± 12 DIV External: ± 6 V	From centre of screen From centre of screen
Triggering slope	+ or –	
Input impedance	1 MΩ//25 pF	Equivalent to input impedance of vertical inputs
Maximum permissible input voltage	400 V, DC + AC peak	
TV triggering	Triggering on Frame pulses (TVF) or Line pulses (TVL)	TIME/DIV 0.28 ... 0.5 ms/DIV: TVF TIME/DIV 0.2 ms ... 0.5 µs/DIV: TVL When the TV filter is switched on, the time base functions in the AUTO mode.
TV trigger sensitivity	internal 0.75 DIV external 0.8 V	sync pulse amplitude sync pulse amplitude

1.2.5. X Deflection

Source	Time-base X via Y_B operation	 If TIME/DIV switch is in position X via B
Deflection coefficients	Ch. B: as selected by AMPL/DIV	
Deflection accuracy	± 15 %	Via Ch. B.
Frequency range	DC: 0 ... 1 MHz (–3 dB)	
Phase shift	3° at 50 kHz	
Dynamic range	24 divisions	For frequencies ⩽ 100 kHz

1.2.6. Probe adjust

Output voltage sufficient for adjusting pulse response of attenuator probes

1.2.7. Power supply

AC supply:	Double insulated	Insulation fulfils the safety requirements of IEC 348 for metal encased Class II instruments.
Nominal voltage range (on line-mains voltage adaptor)	110, 127, 220 or 240 Va.c. ± 10 %	
Nominal frequency range	46 ... 440 Hz	
Power consumption	20 W max.	At nominal mains voltage

The instrument can be equipped with an optional unit for external 24 Volt DC supply (see also 3.4.):

DC supply voltage	23 V ± 10 %
DC supply current	The external power source must be able to deliver a current of at least 1,2 A.

1.2.8. Environmental conditions

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

Designation	*Specification*	*Additional Information*
Ambient temperature:		
Rated range of use	+5 °C ... +40 °C	
Limit range of operation	–10 °C ... +55 °C	
Storage and transport conditions	–40 °C ... +70 °C	
Altitude	Operating : to 5000 m (15000 ft) non-operating : to 15000 m (45000 ft)	
Humidity	21 days cyclic damp heat 25 °C ... 40 °C	R.H. = 95 %
Shock	30 g: half sine-wave shock of 11 ms duration: 3 shocks per direction for a total of 12 shocks.	
Vibration	3 g: vibrations in three directions with a maximum of 15 min. per direction; 10 minutes with a frequency of 15-25 Hz and amplitude of 1 mm peak-peak: 5 min. with a frequency of 25-55 Hz and an amplitude of 0,5 mm p-p. Unit mounted on vibration table without shock absorbing material.	
Recovery time	Operates within 30 minutes of being transferred from –10 °C soak, to 60 % relative humidity at +20 °C room conditions.	
Electromagnetic interference	Meets VDE, Störgrad K.	

1.2.9. Mechanical data

Dimensions:		
Length	550 mm	Including handle
Width	320 mm	Including handle
Height	150 mm	Including feet
Weight	7,5 kg	

1.3. ACCESSORIES

1.3.1. Supplied with the PM 3211

Front cover
BNC - 4 mm Banana adaptor
Manual

1.3.2. Supplied with the PM 3211Q

Front cover
2 Attenuator probes PM 9326/40 (for description see section 1.3.3.).
Manual.

1.3.3. Characteristics of the PM 9326/40 attenuator probe

INTRODUCTION

Two probes of this type are supplied with the PM 3211Q.
The passive attenuator probe PM 9326/40 consists of a measuring cable with BNC connector and a plug-on probe to be used with oscilloscopes having a bandwidth up to 15 MHz and an input resistance of 1 MΩ.

TECHNICAL DATA

Attenuation	10x, ± 3 %
Input resistance	10 MΩ, ± 3 %
Input capacitance	8 pF, ± 2 pF
Rise-time	7 ns
Compensation range input	10 ... 55 pF
Max. allowable input voltage (probe only)	1000 Volt, DC + AC peak

The tolerances apply when the probe is connected to an oscilloscope with nominal input resistance. The max. allowable input voltage of the oscilloscope in both AC and DC position of the input coupling switch must be taken into account.

ACCESSORIES

1 probe cable	5322 321 20087
1 earth cable	5322 321 20134
1 probe 10:1	5322 210 70044
1 test clip	5322 264 20016
Also available:	
1 resistor for attenuator probe	5322 111 20155

MATCHING THE PROBE TO THE OSCILLOSCOPE INPUT

- Display a time-base line by selecting the LINE trigger mode: depress the trigger source selector pushbuttons A and B simultaneously.
- Set the LEVEL control to the AUTO position.
- Release the CH. A AC/DC pushbutton.
- Set the CH. A AMPL/DIV switch to the 5 mV/DIV position.
- Connect the probe to the CH.A input socket X2 and place the tip of the probe on the socket PROBE ADJ.
- Set the TIME/DIV switch to the 0.5 ms or 0.2 ms/DIV position.
- Unscrew the probe locking nut by turning it anti-clockwise (see Fig. 1.2.).
- Rotate the probe body to change capacitance, in the same time watching the display for the desired waveform (see Fig. 1.2.).
- After completion of the compensation procedure carefully turn the locking nut clockwise to lock it, without disturbing the adjustment.

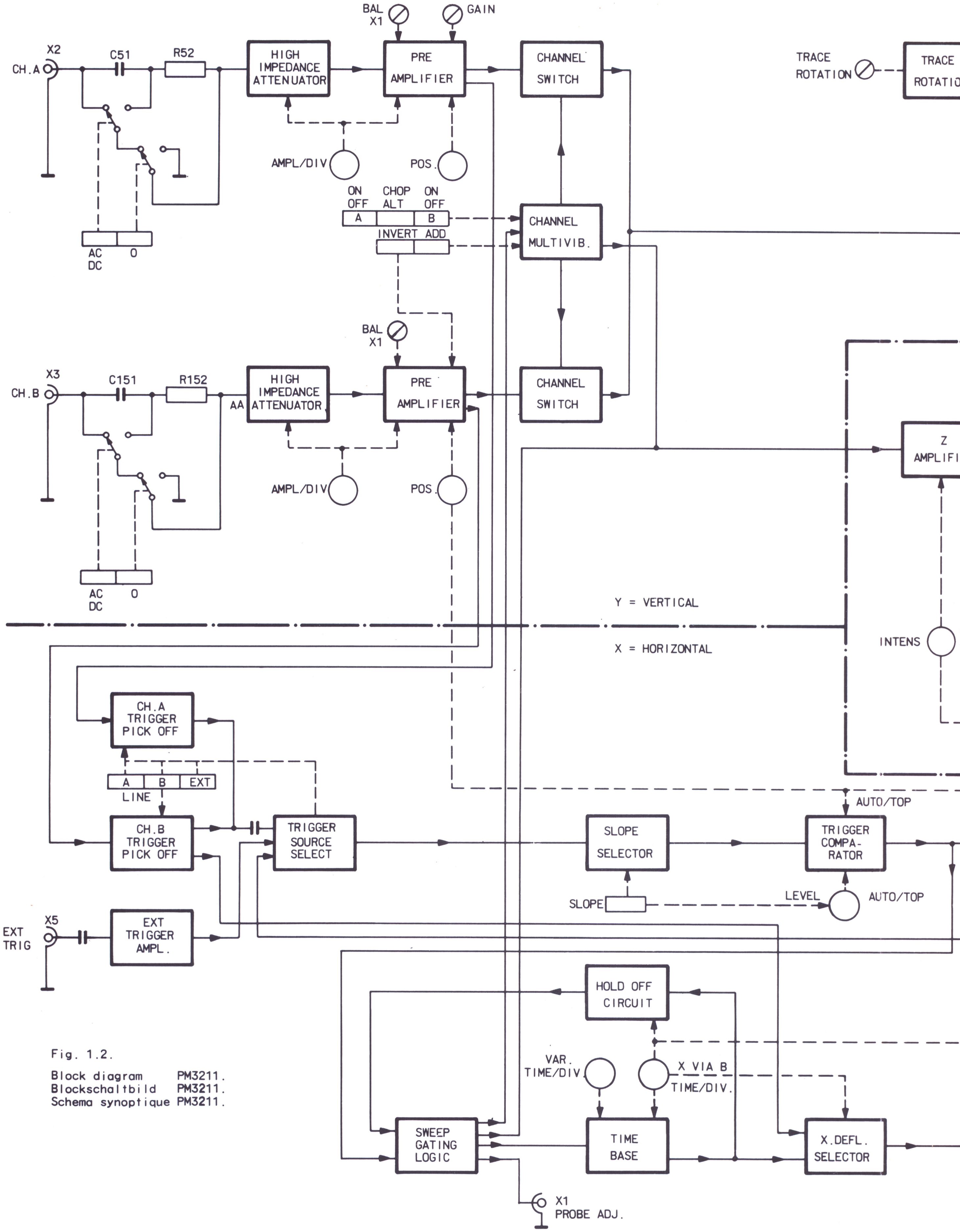
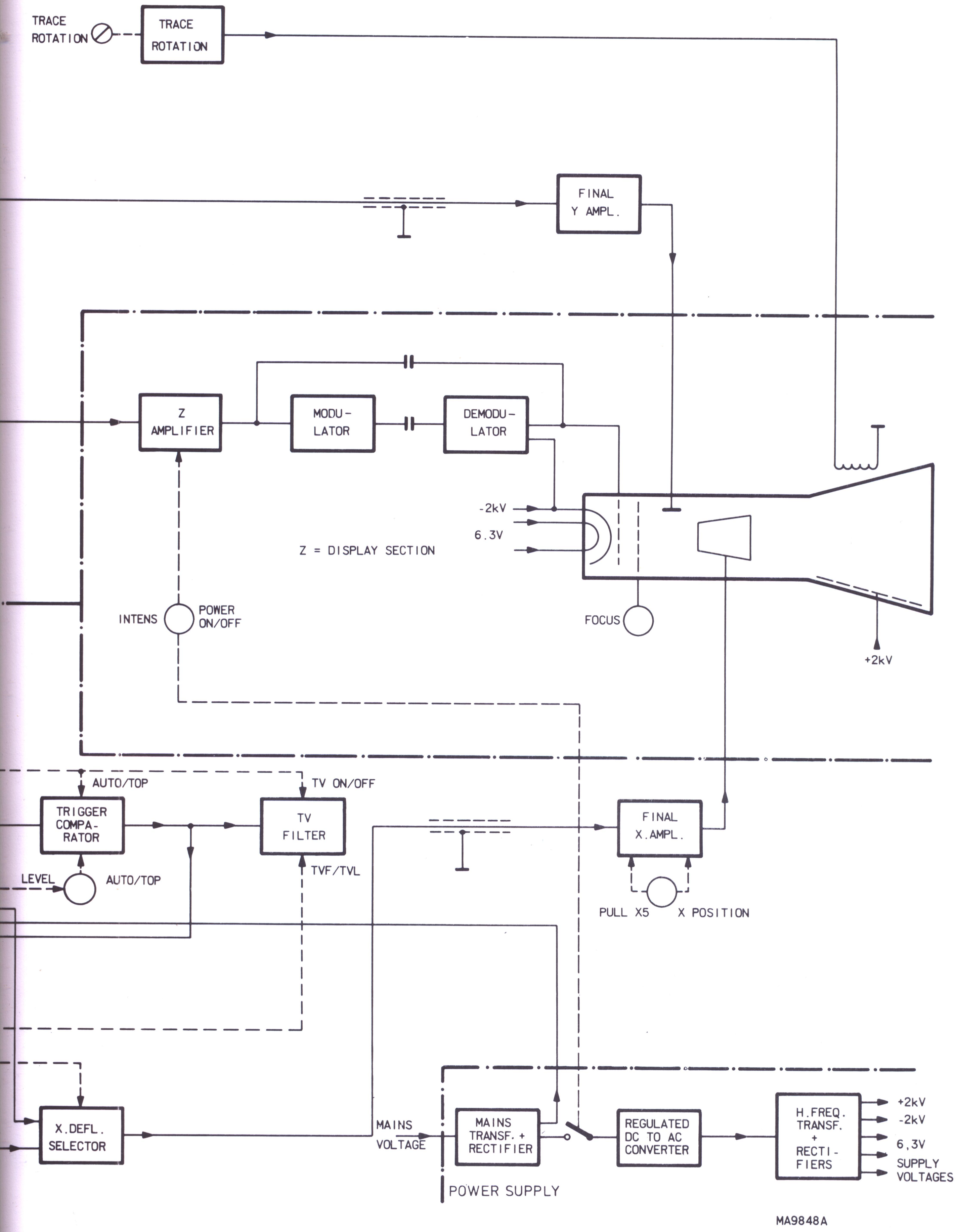


Fig. 1.2.

Block diagram PM3211.
Blockschaltbild PM3211.
Schema synoptique PM3211.

Fig. 1.3. *Block diagram of the oscilloscope*
Abb. 1.3. *Blockschaltbild des Oszillografen*
Fig. 1.3. *Schéma synoptique de l'oscilloscope*


TRACE ROTATION
TRACE ROTATION
FINAL Y AMPL.
Z AMPLIFIER
MODU-LATOR
DEMODU-LATOR
-2kV
6.3V
Z = DISPLAY SECTION
INTENS
POWER ON/OFF
FOCUS
+2kV
AUTO/TOP
TV ON/OFF
TRIGGER COMPA-RATOR
TV FILTER
FINAL X.AMPL.
LEVEL
AUTO/TOP
TVF/TVL
PULL X5
X POSITION
X.DEFL. SELECTOR
MAINS VOLTAGE
MAINS TRANSF. + RECTIFIER
REGULATED DC TO AC CONVERTER
H.FREQ. TRANSF. + RECTI-FIERS
+2kV
-2kV
6,3V
SUPPLY VOLTAGES
POWER SUPPLY
MA9848A

1.3.4. Optional

PM 9326 : Passive probe 1:1/10:1 (1.1 m)
PM 9327 : Passive probe 1:1/10:1 (2.1 m)
PM 8921 : Passive probe 1:1 (1.5 m)
PM 8921L : Passive probe 1:1 (2.5 m)
PM 8925 : Passive probe 10:1; 11 pF (1.5 m)
PM 8925L : Passive probe 10:1; 14 pF (2.5 m)
PM 8932 : Passive probe 100:1; max voltage 5600 V; 2 pF (1.5 m)
PM 9353 : Active FET-probe 1:1; 10:1; 3.5 pF
PM 9355 : Current probe; 12 Hz ... 70 MHz
PM 9346 : Power supply for active probes
PM 8910 : Polaroid anti-glare filter
PM 9380 : Oscilloscope camera
PM 8971 : Camera adaptor
PM 8962 : 19" rackmount adaptor
PM 9366 : Collapsible viewing hood
PM 8980 : Closed, long type viewing hood
PM 8991 : Trolley
PM 8992/01 : Accessory pouch

Accepts Steinheil Oscillophot ® cameras M3, M4 and M5 using Steinheil adaptor 1820/50.

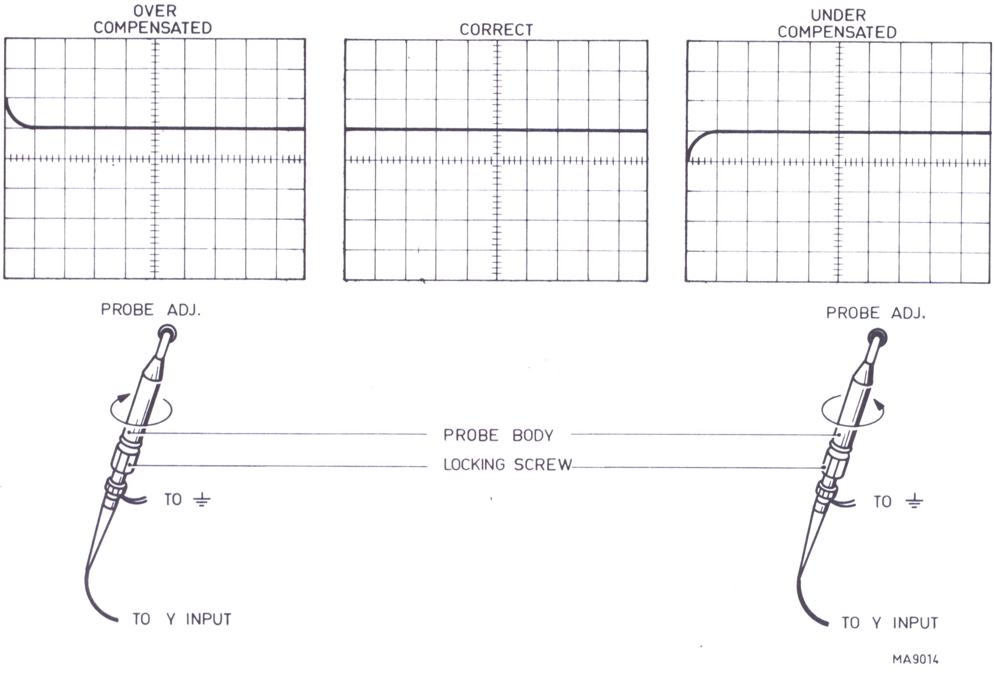


Fig. 1.2. Matching the attenuator probe PM 9326/40 to the oscilloscope input.

1.4. DESCRIPTION OF THE BLOCK DIAGRAM

The circuit is located on three printed-circuit boards that contain the following circuit parts:

a. Main unit : vertical stages (except final amplifier) triggering, time-base and horizontal preamplifier, trace rotation.

b. Final amplifier unit : final vertical amplifier
final horizontal amplifier
Z-amplifier

c. Power supply unit.

The block diagram of the PM 3211 is given in Fig. 1.3. Note that the sub-division of the diagram does not relate to the circuit areas of the printed-circuit boards.
The diagram is split up into four functional areas, namely: vertical, horizontal, display section and power supply.

1.4.1. Vertical deflection

As the A and B channel are almost identical, only one channel is described.
The signal at the input socket is applied directly or via a DC blocking capacitor – depending on the position of the AC/DC coupling switch – to the HIGH IMPEDANCE ATTENUATOR stage. Depressing the "0"-pushbutton connects the attenuator input to earth. The HIGH IMPEDANCE ATTENUATOR, which incorporates the attenuation coefficients 100, 10 and 1, is followed by a PREAMPLIFIER stage. This PREAMPLIFIER incorporates the following functions:

- The 1-2-5 attenuator sequence
- A X10 gain increase for the three most sensitive AMPL/DIV switch positions.
- The BALANCE adjustment (BAL X1)
- The GAIN adjustment (for channel A only)
- The INVERT function of channel B
- The POSITION control.

The PREAMPLIFIER has two outputs, one of which feeds the TRIGGER PICK OFF amplifier. The other output feeds the block marked CHANNEL SWITCH. This CHANNEL SWITCH is able – depending on a command signal – to switch the preamplifier output signal through to the FINAL Y AMPLIFIER. The FINAL Y AMPLIFIER feeds the vertical deflection plates of the CATHODE RAY TUBE (CRT).
The command signals for both channel switches are generated by the CHANNEL MULTIVIBRATOR. This multivibrator is controlled by the pushbuttons Ch. A ON/OFF, Ch. B ON/OFF, CHOP/ALT and ADD.
For ALTERNATE mode an input signal derived from the time-base is used.
The following modes are possible:

- One channel operation: one channel is continuously switched through to the final Y amplifier while the other channel is blocked.
- Dual-channel operation in ALTernate mode: the final Y amplifier input is switched over from one channel to the other at the end of each time-base sweep.
- Dual-channel operation in CHOPped mode: the final Y amplifier input is switched over from one channel to the other at a frequency of 500 kHz.
- ADDed: both channels are simultaneously switched through to the final Y amplifier and addition of both channels takes place.
- Subtracted: both channels simultaneously switched as for added mode, but Ch. B inverted.

1.4.2. Triggering and horizontal deflection

The signal-source on which the time-base must trigger is selected with the TRIGGER SOURCE SELECTOR. This block can select the following triggering sources:

- The Ch. A or Ch. B TRIGGER PICK-OFF AMPLIFIERS which are activated by the pushbuttons A and B.
- The EXTERNAL TRIGGER PREAMPLIFIER in order to trigger on a signal applied to the external input X5. This possibility is activated when depressing the EXT pushbutton.
- A signal derived from the mains/line voltage when depressing the A and B pushbuttons together.

The selected triggering signal is applied to the input of the +/– SLOPE SELECTOR, which permits triggering on the positive or negative slope of this signal respectively. Depending on the position of the +/– pushbutton this block gives a phase shift of respectively 180° or 360°.

The SLOPE SELECTOR feeds the block TRIGGER COMPARATOR, which enables adjustment of the level of the triggering signal at which the time-base starts. Triggering on an adjustable level is possible with the LEVEL control; triggering on the top of the triggering signal is possible in the AUTO mode. Both the LEVEL control and the AUTO switch are operated by the same knob.

The TV filter which is connected to the comparator's output, makes triggering on frame (TVF) or line (TVL) pulses possible. The selection of line or frame pulses depends on the time-base TIME/DIV switch setting.
See section 2.2.3.

If the HOLD-OFF CIRCUIT gives a ready signal, the SWEEP GATING LOGIC starts the TIME-BASE at the reception of a trigger command from the TRIGGER COMPARATOR.

The HOLD-OFF CIRCUIT prevents the sweep gate circuit from responding to a trigger command before the time-base capacitor has been fully discharged. There are two hold-off times, which are determined by the TIME/DIV switch setting, one hold-off time for the sweep times from 0,2 s ... 0,5 ms/DIV and one for the sweep times from 0,2 ms ... 0,5 μs/DIV. When switching over from the slow sweep to the fast sweep hold-off time, the TV FILTER is switched over from FRAME to LINE pulse selection.

The SWEEP GATING LOGIC, in addition to the output that switches the time-base, has an output that feeds the CHANNEL MULTIVIBRATOR in order to facilitate the ALTERNATE vertical display mode.
A third output is used to control the Z-AMPLIFIER in order to blank the trace during the flyback of the time-base.

The TIME-BASE generates the sawtooth that is used for horizontal deflection. The sweep time can be adjusted with the step control TIME/DIV. The continuous control VARIABLE time/div enables adjustment of sweep times between the TIME/DIV control steps.

The X-DEFLECTION SOURCE SELECTOR selects the input signal for the FINAL X-AMPLIFIER.
In normal time-base operation the sawtooth is selected. In the X via B mode, an output signal from the Ch. B trigger pick-off amplifier is selected.

The FINAL X-AMPLIFIER, which drives the horizontal deflection plates of the CRT, has a X-POSITION control. This potentiometer is combined with a PULL FOR X5 time-base magnifier, which increases the horizontal gain 5 times.

1.4.3. CRT display section

The Z-AMPLIFIER receives an input blanking signal which originates from the channel multivibrator and the sweep-gating logic. Blanking of the trace takes place during the flybrack of the time-base and in chopped mode during switching over from one channel to the other. The control INTENS determines the amount of current fed into the Z-AMPLIFIER.

The output signal of the Z-AMPLIFIER must reach the control electrodes of the CRT, which are at a potential of –2 kV. Two blocking capacitors are used to separate the Z-output d.c. voltage from the CRT voltage of –2 kV. The h.f. component in the Z-output signal is fed via one blocking capacitor to the Wehnelt cylinder of the CRT. The l.f. and d.c. component are modulated by means of the MODULATOR block on a 200 kHz carrier signal, which is transferred through the second blocking capacitor. This capacitor is connected to a DEMODULATOR which feeds the Wehnelt cylinder.

The block TRACE ROTATION, which is operated by a front panel screwdriver control, makes adjustment possible of the current (strength and sense) through the trace-rotation coil of the CRT. This provision facilitates alignment of the time-base trace with the horizontal graticule lines.

1.4.4. Power supply

MAINS TRANSFORMER + RECTIFIER: the LINE (mains) voltage is transformed by means of a double-insulated mains transformer and afterwards rectified to 46 Volt d.c.

This d.c. voltage is applied to the REGULATED DC TO AC CONVERTER. This converter generates a regulated square-wave voltage of approximately 16 kHz, which is applied to the block H.F. TRANSFORMER + RECTIFIERS. This block has several d.c. output voltages that feed the various parts of the instrument.

2. Directions for use

2.1. INSTALLATION

2.1.1. Safety regulations (in accordance with IEC 348)

Before connecting the instrument to the mains (line), visually check the cabinet, controls and connectors etc., to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect instrument to the mains (line).

The instrument must be disconnected from all voltage sources, and any high voltage points discharged before any maintenance or repair work is carried out. If adjustments or maintenance of the operating instrument with covers removed is inevitable, it must be carried out only by a skilled person who is aware of the hazards involved. In normal operation the double-insulated power supply obviates the need of a safety ground.

Warning: **It must be borne in mind that in all instruments the frame ground of the oscilloscope is raised to the same potential as that of the measuring ground probe connection.**
Neither the probe's ground lead nor the frame ground shall be connected to live potentials.

2.1.2. Local mains (line) connection and fuse protection

Before connecting the instrument to the mains (line), make sure that it is set to the local mains (line) voltage. On delivery the instrument is set to 220 V. If the instrument is to be used with 110 V, 127 V or 240 V supply, the appropriate voltage should be selected by turning the adaptor on the rear panel to indicate the voltage required (see Fig. 2.1.). When turning the adaptor disconnect the instrument from the mains.
The instrument is protected against overloads by means of a fast 500 mA fuse (F801), which is located on the power supply printed circuit board, and a thermal fuse. This thermal fuse, which is located in the mains transformer protects it against excessive temperatures in order to prevent damage to the double insulation.

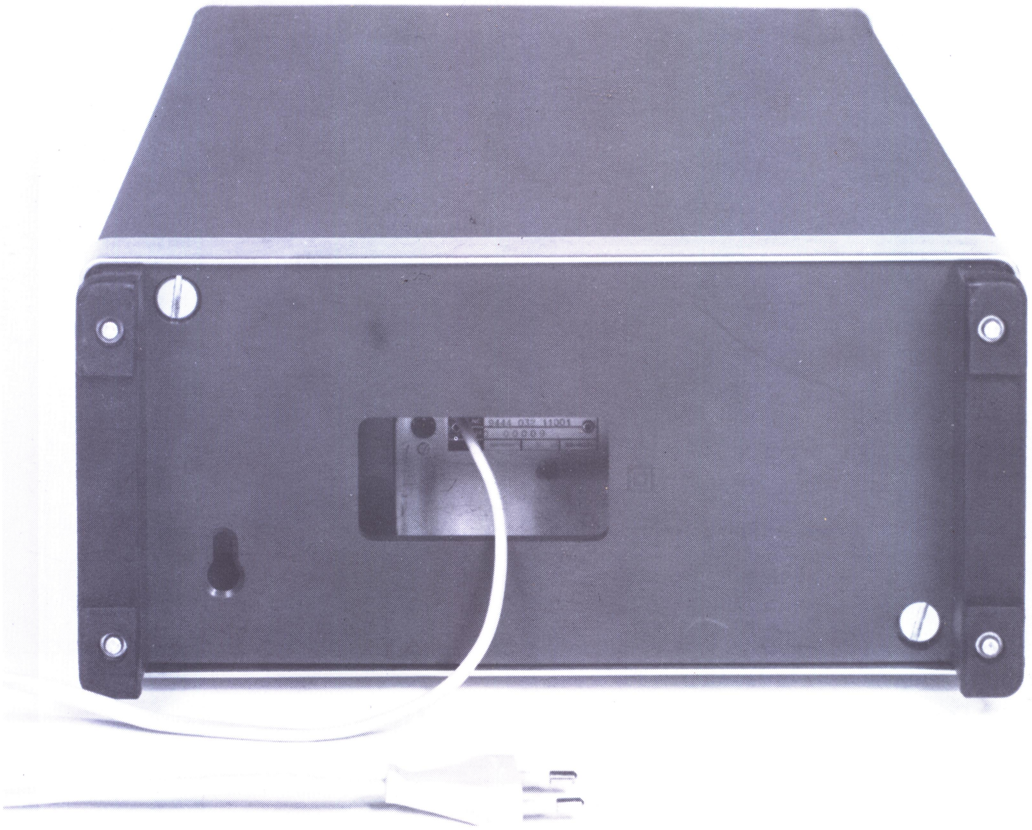


Fig. 2.1. Rear view of the oscilloscope

2.1.3. Connection to an external 24 V DC supply

The instrument can be equipped with an optional unit for external 24 V DC supply.
The external supply or battery of 23 V (± 10 %) capable of delivering at least 1,2 A can be connected to the socket on the rear panel of the instrument (for instance via DC power input cord set 4822 321 20125).
The inner conductor of the socket must be connected to the negative pole and the outer conductor to the positive pole.
The external power converter is protected against overloads by a 2 A fuse. This fuse can be replaced after having removed the wrap-around cover from the instrument. For more information see section 3.4.

2.1.4. Front cover and instrument position

The front cover can be simply removed by pulling it from the front.
The instrument may be used horizontally or in several sloping positions by using the carrying handle as a tilting bracket. To unlock the handle, simultaneously push in both pivot centre knobs, as indicated in Fig. 2.2.

2.2. CONTROLS AND SOCKETS (Refer to Fig. 2.2.)

2.2.1. Cathode-ray tube and POWER controls

INTENS/POWER ON	Continuously variable control of the trace brilliance incorporated with th mains switch. Pilot Lamp indicates the ON state.
FOCUS	Allows beam to be focused for minimum spot size.
TRACE ROTATION	Srewdriver adjustment to align the trace with the horizontal graticule lines.

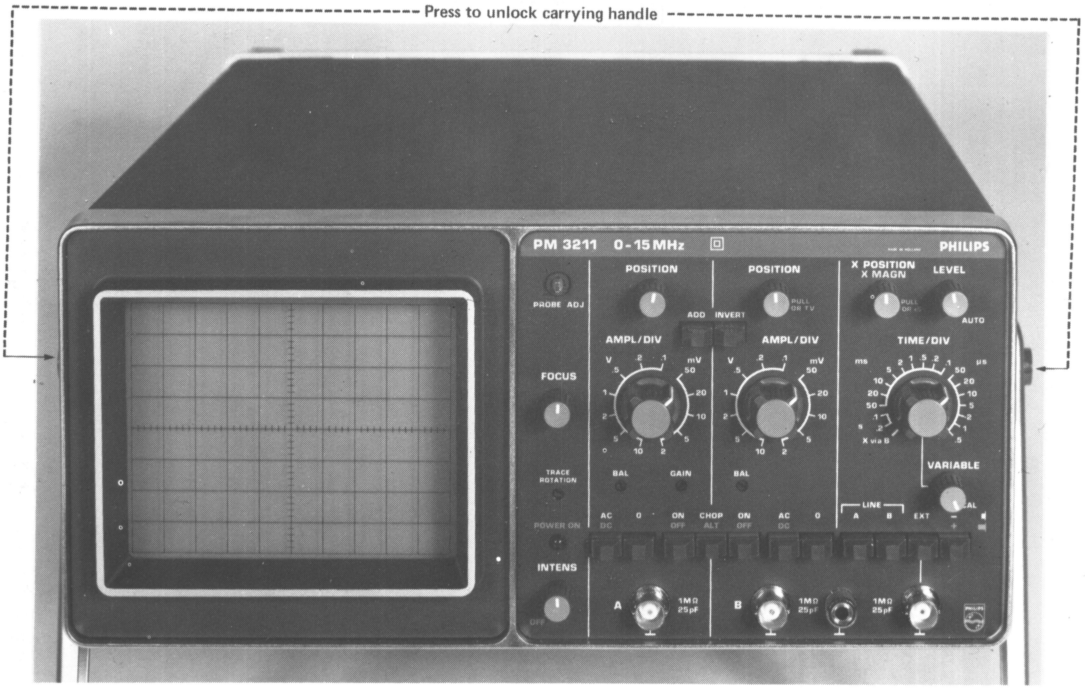


Fig. 2.2. Front view of the oscilloscope showing controls and sockets.

2.2.2. Vertical deflection

A	BNC socket for channel A input
B	BNC socket for channel B input
AC/DC	When depressed: coupling via a blocking capacitor When released : direct coupling
0	When depressed: Connection between input circuit and input socket is interrupted and the input circuit is earthed.
ON/OFF CH. A	The input signal applied to socket A is displayed when this button is depressed.
ON/OFF CH. B	The input signal applied to socket B is displayed when this button is depressed. If no button is depressed only one channel is displayed. The selected channel is not specified.
CHOP/ALT	If CH. A and CH. B are both in the ON state they can be displayed in the chopped (CHOP) or the alternate (ALT) mode. ALT: The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal. CHOP: The display is switched over from one vertical channel to the other at a fixed frequency. (f ≈ 500 kHz).
INVERT CH. B	The CH.B signal is inverted when this button is depressed.
ADD	Vertical deflection is achieved by the sum signal of the channels A and B
AMPL/DIV	Step control of the vertical deflection coefficients, ranging from 2 mV/div up to 10 V/div in a 1-2-5 sequence.
POSITION	Continuously variable controls giving vertical shift of the display.
BAL. CH. A (CH. B)	This screwdriver front-panel adjustment point is adjusted for minimum trace jump when switching the CH. A (CH. B) AMPL/DIV knob from 2 to 5 mV/DIV.
GAIN CH. A	With this screwdriver front-panel adjustment point the gain of CH. A is set to equal the gain of CH. B. This is necessary to obtain a minimum C.M.R. factor in the A-B mode. (See section 2.3.7. for further information).

2.2.3. Time-base

TRIGGER SOURCE A	When the button is depressed the time-base can trigger on a signal derived from CH. A.
B	When this button is depressed the time-base can trigger on a signal derived from CH. B.
LINE	When the CH. A and CH. B trigger source pushbuttons are both depressed the time-base can trigger on a signal derived from the line (mains) voltage.
EXT	When this button is depressed the time-base can trigger on a signal applied to the external trigger input.
No pushbutton depressed	In this situation the time-base trigger on a signal derived from CH. A.
LEVEL	Enables adjusting of the level of the triggering signal at which the time-base starts.
AUTO	This is the end position of the LEVEL control In this position the time-base triggers automatically on the top level of the triggering signal. Moreover, the time-base runs free in the absence of a triggering signal.

+/– SLOPE	Enables triggering on the positive-going (button released) or negative-going (button depressed) slope of the triggering signal.
TIME/DIV	Selects the time coefficient from 0,5 µs/DIV to 0,2 s/DIV in a 1-2-5 sequence. In the position X via B, horizontal deflection is determined by the CH. B input signal.
VARIABLE TIME/DIV	Continuously variable control of the time coefficients between the TIME/DIV steps. The control must be in the CAL position for the time axis to be calibrated according to the indication of the TIME/DIV switch.
PULL FOR TV	The TV filter is switched on if the Channel B POSITION knob is pulled. Moreover the time-base functions in the AUTO mode then. Triggering on frame pulses (TVF) occurs with the TIME/DIV switch in the range 0.2 s ... 0.5 ms/DIV. Triggering on line pulses (TVL) occurs with the TIME/DIV switch in the range 0,2 ms ... 0,5 µs/DIV. The +/– SLOPE button is used to adjust the instrument for positive and negative video signals.

2.2.4. Horizontal deflection

TIME/DIV X VIA B	If the TIME/DIV switch is one of the positions between 0,2 s/DIV and 0,5 µs/DIV, the horizontal deflection is achieved by the time-base generator. If the TIME/DIV switch is in the X VIA B position, the horizontal deflection is achieved by the signal applied to the CH. B input. In this mode CH. B must be switched off (S13 released) and CH. A must be switched on (S11 depressed) in order to become only horizontal deflection.
X POSITION PULL FOR X5	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection by a factor of 5.

2.2.5. Miscellaneous

PROBE ADJ.	Output socket supplying a signal voltage which is sufficient for adjusting the pulse response of attenuator probes (see section 1.33 and 2.35).
LINE (MAINS) VOLTAGE ADAPTOR	Must be set according to section 2.1.2. before the instrument is connected to the local mains voltage

2.3. OPERATING INSTRUCTIONS

2.3.1. Switching on the instrument

Before connecting the instrument to any supply, the instructions given in section 2.1. Installation, should be carefully carried out.

The oscilloscope will meet specifications (see section 1.2.) normally after a warming-up period of approximately 15 minutes. However, if the instrument has been subjected to an extremely cold environment (e.g. left in a car overnight in freezing conditions) and is then brought in for use in a warm room, a warming-up period of sufficient duration should be allowed (see 1.2.8.).

2.3.2. Preliminary settings of the controls (POS. CH. A, POS. CH. B, X POS, INTENS, FOCUS)

This procedure is a general indication of whether the oscilloscope is functioning correctly and provides as suitable starting point before any measurements are made.

Refer to Fig. 2.2. for location of controls.

Set INTENS and FOCUS controls in mid position.

Put the instrument in the AUTO mode and select an average time coefficient between 10 ms/DIV and 10 10 μs/DIV with the TIME/DIV switch. Switch channel A and B on with all the other pushbuttons not depressed. The channel A and channel B traces can be positioned on the screen with the relevant Y and X POSITION controls. Set the INTENS control for a display of medium brightness and adjust FOCUS control for well focussed traces.

2.3.3. Input coupling (AC/DC, 0)

AC coupling (pushbutton depressed) is useful to block the d.c. component of a signal consisting of an AC component superimposed on a DC component. Choice of AC limits the lower frequencies, causing low repetition rate sinewave signals to be attenuated and low repetition rate squarewaves to be distored. The degree of attenuation is determined by the input RC time (22 ms). Input RC time is extended by 10 if 10:1 passive probes are employed.

When switching to AC coupling it will take approximately five input RC times before the trace is stabilised to the average value of the input signal.

AC position measurements cannot be made with respect to ground.

0 position disconnects input source and short-circuits input of the amplifier to provide zero signal check.

DC coupling (pushbutton released) provides for full range frequency input, i.e. down to d.c.

2.3.4. Use of probes

1:1 passive probes should only be used for d.c. and low frequencies.
Capacitive loading attenuates high frequencies or increases the rise-time of measurement signals (dependent on source impedance).

10:1 passive probes have less capacitive loading; usually about 10 pF to 20 pF. FET probes are superior, especially when measurements are to be taken from high impedance test points or at the upper frequency limit of the oscilloscope bandwidth.

10:1 passive probes must be properly compensated before use. Incorrect compensation leads to pulse distortion or amplitude errors at high frequencies.
For correct adjustment, the PROBE ADJ output connection can be used (see Fig. 2.3.).

2.3.5. Adjustment of attenuator probes PM 8925, PM 8925L and PM 8932 (PROBE ADJ)

- Display a time-base line by selecting the LINE trigger mode; depress the trigger-mode pushbutton A and B simultaneously.
- Put the LEVEL control in the AUTO position.
- Release the CH. A AC/DC pushbutton (S9).
- Put the CH. A AMPL/DIV switch (S5) in the 5 mV/DIV position.
- Connect the compensation box to the CH. A input socket (X2) and place the top of the probe on socket PROBE ADJ.
- Put the TIME/DIV switch (S7) in the 0,5 ms or 0,2 ms/DIV position.
- Insert a small screwdriver through the hole in the compensation box and adjust the trimmer to obtain a correct display as shown in Fig. 2.3.

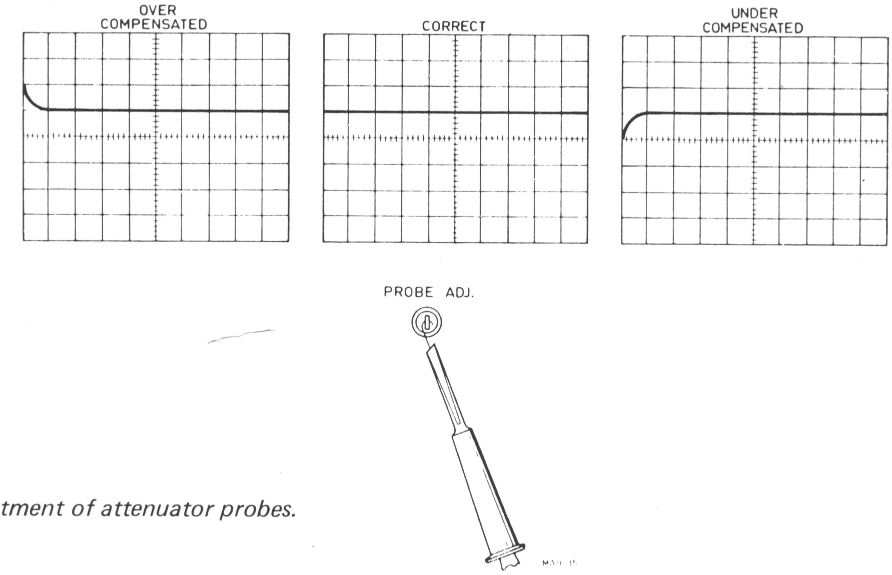


Fig. 2.3. Adjustment of attenuator probes.

2.3.6. **Selection of chopped or alternate modes** (CHOP/ALT)

In dual-channel operations the chopped modes (depress CHOP/ALT) must be selected for relatively slow sweep speeds from 0,2 s/DIV ... 0,1 ms/DIV or at low repetition of sweeps occurring, even at high sweep rates. Selection of the ALTernate mode under these circumstances would make comparisons between waveforms difficult because traces would actually appear to be written one by one. However, when the display is fast enough to be interrupted by the chopping frequency the alternate mode must be selected (release CHOP/ALT) usually at sweep rates faster than 0,1 ms/DIV.

2.3.7. **Differential mode** (ADD, CH. B INVERT, CH. A GAIN)

The A-B mode can be selected by depressing the pushbuttons ADD and INVERT.

In measurements where signal lines carry substantical common-mode signals (e.g. hum) the differential mode will cancel out these signals and leave the remainder of interest (A-B). The capability of the oscilloscope to suppress common-mode signals is given by the CMR factor (see Fig. 2.4.).

To obtain the degree of common-mode rejection as specified, channel A and B gains must first be equalised. This can be done by connecting both channels to the same signal, and adjusting the CH. A GAIN (front-panel screwdriver control) to minimum deflection on the screen.

When passive 10:1 probes are used a similar equalisation process is recommended by adjusting their compensating controls for minimum deflection.

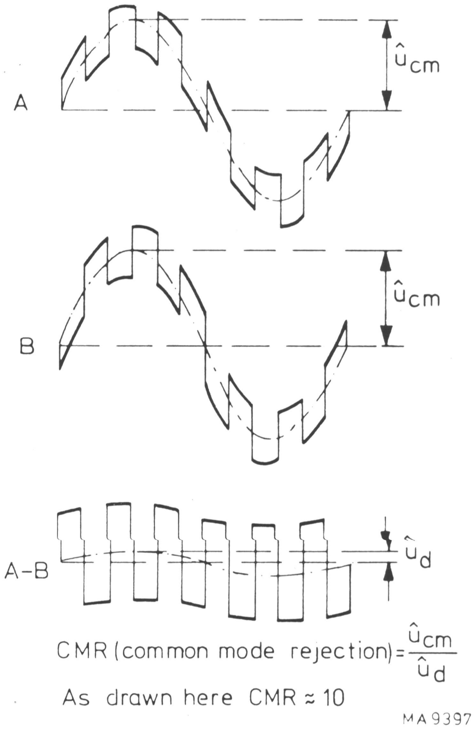


Fig. 2.4. Suppression of common-mode signals

2.3.8. **Trigger source selection** (A, B, LINE, EXT)

The trigger source selector enables selection of the signal on which the time-base can trigger.
The trigger sources can be:

- **A or B:** triggering occurs on a signal derived from the CH.A or CH. B vertical input signal.
  In comparing waveforms that are a multiple of each other's frequency, always select the signal, that has the lowest repetition rate as the trigger source. Failure to do so may lead to double pictures (chopped mode) or untrue time shifts (alternate mode).
- **LINE:** line/mains triggering is useful when the signal to be measured is mains frequency related.
- **EXT:** when tracing many signals it is advantageous to use an external signal for triggering. There is no need to set and reset the trigger controls (LEVEL, SLOPE and SOURCE) on changing the input signal.
  Furthermore, the two A and B inputs remain free for examining waveforms.
- If no button is depressed the time-base will trigger on a signal derived from CH. A.

The trigger selector is a.c. coupled. Because of this, the level at which the display starts will change with alterations in the average value of the trigger signal. So the trigger level is not referenced to signal earth. This may cause instability with waveforms that vary in time interval from cycle to cycle. If this is unacceptable, switch to AUTO mode in order to obtain top level triggering.

2.3.9. **Selection of the trigger mode** (AUTO, LEVEL, SLOPE)

The AUTO mode (LEVEL control fully clockwise) is most useful because it provides trace(s) on the screen even in absence of trigger signals, because the time-base becomes free-running 100 ms after the last trigger signal occurred.
In the AUTO mode triggering occurs on the top of the trigger signal.

The AUTO mode cannot be employed for signals with repetition rates of 20 Hz or lower because then the time-base is enabled to work in the free run mode. In such a situation the normal trigger mode must be used: the LEVEL control rotated out of the AUTO position and set appropriately.

The +/– SLOPE pushbutton selects the time-base to be triggered on the positive or negative slope of the trigger signal.

2.3.10. **X VIA B measurements** (TIME/DIV)

X VIA B measurements are made with the TIME/DIV switch in the X VIA B position.
X VIA B measurements provide a useful means at making frequency or phase comparisons by displaying Lissajous patterns.
Measurements can be made up to 50 kHz with less than 3° phase error between the horizontal and vertical deflection channel.
The X sensitivity = AMPL/DIV CH. B, ± 15 %.

2.4. REMOVAL OF FUSES, SCREEN BEZEL, CONTRAST AND GRATICULE PLATE

2.4.1. Removing the instrument covers

Before removing the instrument covers disconnect the instrument from the mains voltage.
Proceed as follows:

- Put the carrying handle in such a position that the instrument can stand on its protective front cover on a flat surface.
- Unscrew the two coin-slot screws on the rear panel.
- Lift the rear panel.
- Lift off the wrap-around cover.
- For access to the front panel, stand the instrument horizontally and snap off the cover.

2.4.2. Replacing the thermal fuse F802

- Remove the instrument covers as indicated in section 2.4.1.
- Remove the plastic mains section cover.
  This cover has four clamps that snap into rectangular holes in the metal rear plate to hold the cover in position. It can then be removed by exerting slight pressure on the side adjacent to the clamps and at the same time taking the cover gently from the rear plate.
- Removal of the fuse element (see Fig. 2.5.).
  Unsolder and remove the mains wires on the fuse side of the transformer.
  Unsolder the fuse terminals.
  Using a small screwdriver, bend the housing of the fuse outwards slightly in order to disengage the locking pin. Now prise the fuse gently out of its housing.
- Installation of a new fuse element.
  Take the new element and remove the housing as described above.
  Push the new element into the housing in the transformer until the locking pin snaps in the hole.
  Now solder both fuse wires and the mains wires.

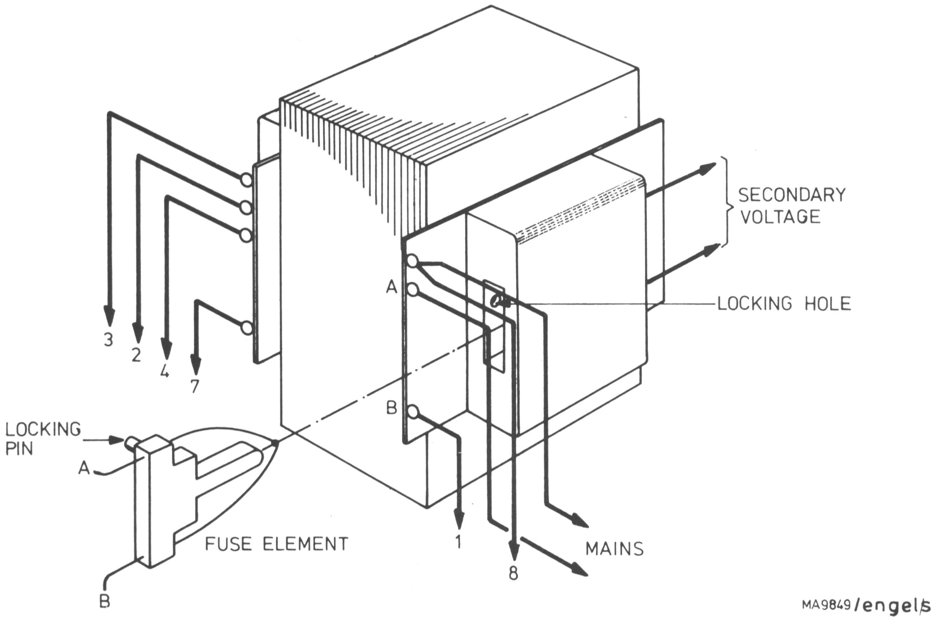


Fig. 2.5. Mains transformer and position of thermal fuse.
The numbers refer to the pin numbers of the mains voltage adapter.

2.4.3. Replacing the fuse F801

- Remove the instrument covers as described in section 2.4.1.
- Change fuse F801 (500 mA, fast), which is located on the power supply printed-circuit board.

2.4.4. Removing the screen bezel and the contrast plate

- Grip the bottom corners of the bezel and gently pull it from the front panel (see Fig. 2.6.).
- The contrast filter can be removed by pressing it gently out of the bezel.

2.4.5. Removing the graticule plate

- Gently ease the graticule plate from the CRT screen using your finger-nails or a small screwdriver.
- Increase this space until it is possible to release the left-hand side of the graticule plate from the front profile.
- After releasing this side the graticule plate can be removed.
  To refit the graticule plate, first install the right-hand side and then the left-hand side.

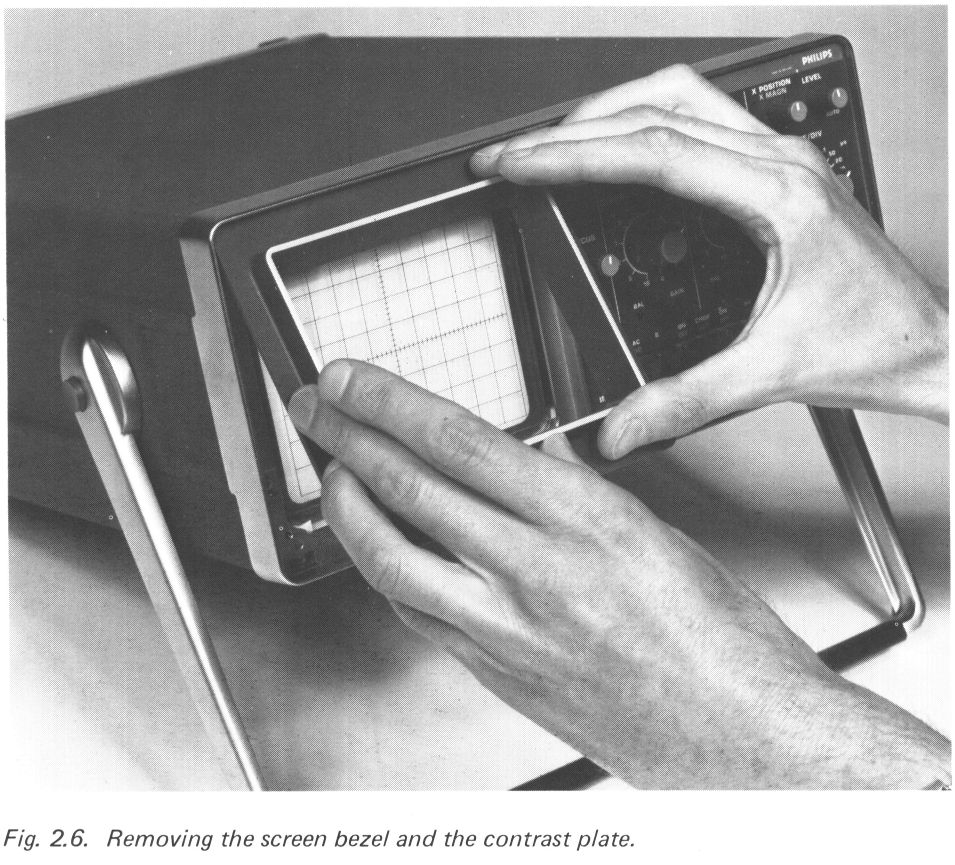


Fig. 2.6. Removing the screen bezel and the contrast plate.

Gebrauchsanleitung

1. Allgemeines

1.1. EINLEITUNG

Der PM 3211 Oszillograf ist ein leichtes Kompaktgerät. Er ist ergonomisch konstruiert und kann durch seine vielseitigen Anwendungsmöglichkeiten für Wartungsarbeiten sowie für Labor und Unterrichtszwecke verwendet werden.

Das Gerät besitzt eine hohe Empfindlichkeit von 2 mV/Teil bei einer Bandbreite von 15 MHz und verfügt über einen 8 x 10 cm grossen Bildschirm mit einer hellen Schreibspur.
Es eignet sich für eine grosse Verschiedenheit an Darstellungsmöglichkeiten, wie ein Kanal, zwei Kanäle alternierend oder gechopped oder beide Kanäle addiert. Kanal B kann normal oder invertiert dargestellt werden.

Das Gerät besitzt mehrere Triggerarten, einschliesslich TV-Triggerung.

Eine doppelt isolierte Stromversorgung erlaubt direkten Anschluss der Geräte-Erde an erdfreie Schaltungen, vorausgesetzt diese Mess-Erde führt keine berührungsgefährlichen Spannungen.
Interferenzen durch Edrströme, wie sie häufig bei geerdeten Oszillografen vorkommen werden auch wesentlich reduziert.

Das PM 3211Q ist die USA-Ausführung des Grundgeräts PM 3211. Entgegen dem Grundgerät werden mit dem PM 3211Q zwei 10:1 Tastköpfe PM 9326/40 geliefert.

WARNUNG: **Die Geräte-Erde (und die Messkopf-Erdleitung) darf nicht mit berührungsgefährlichen Spannungen verbunden werden.**

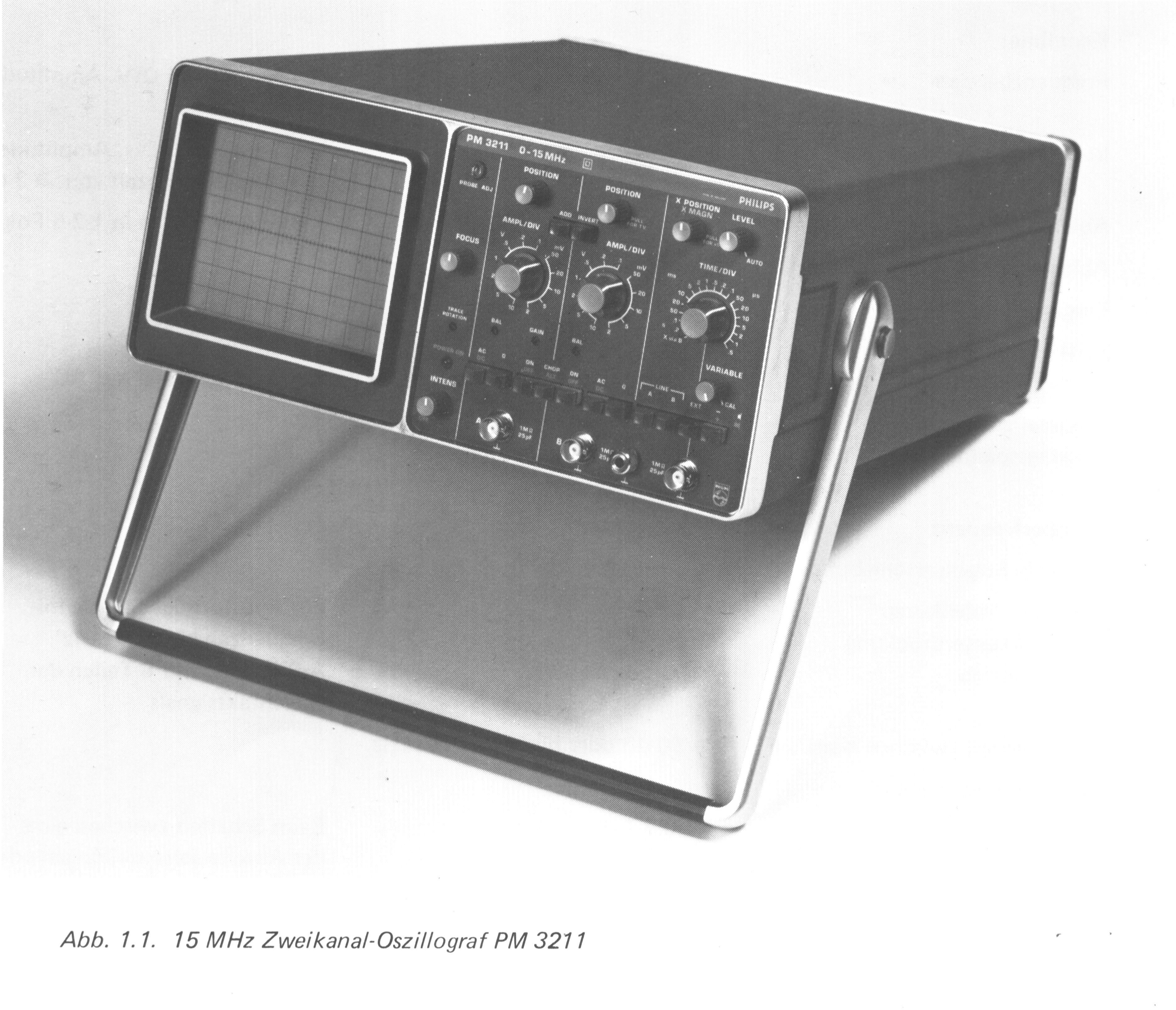


Abb. 1.1. 15 MHz Zweikanal-Oszillograf PM 3211

1.2. KENNDATEN

Dieses Gerät ist gemäss IEC 348 für Geräte der Schutzklasse II entworfen und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Zur Erhaltung dieses Zustands und seines gefahrlosen Betrieb sind die in dieser Anleitung enthaltenen Informationen und Warnung sorgfältig zu beachten. Zahlenwerte mit Toleranzangaben werden bei Umgebungstemperaturen von +5 °C ... +40 °C garantiert, falls nicht anders angegeben. Zahlenwerte ohne Toleranzangaben sind Durchschnittswerte und dienen nur zur Information.

Bezeichnung	*Beschreibung*	*Nähere Angaben*
1.2.1. Elektronenstrahlröhre		
Typ	D14-260GH	
Nutzbare Bildschirmfläche	8 x 10 Teile	1 Teil eintspricht 1 cm
Bildschirmtyp	P31 (GH) Standard	P7 (GM) wahlweise
Gesamtbeschleunigungsspannung	4 kV	
Raster	Aussenraster	
1.2.2. Vertikalverstärker		
Darstellungsarten	Kanal A allein Kanal B allein A und B gechopped A und B alternierend A und B addiert	
Eingangskopplung	AC, DC, 0	
Kanal B Polarität	Normal oder invertiert	
Kennlinie:		
Frequenzbereich	DC: 0 ... 15 MHz (–3 dB) AC: 10 Hz ... 15 MHz (–3 dB)	Gemessen bei 6 DIV. Amplituden
Impulsverformungen	< ± 3 %	Gemessen bei 6 Div. Amplituden mit einer Anstiegzeit von ⩾ 3 ns.
Ablenkkoeffizienten	2 mV/DIV ... 10 V/DIV	Kalibrierte Stufen in 1-2-5 Folge
Ablenk-Fehlergrenze	± 3 %	
Eingangsimpedanz	1 MΩ//25 pF	
Zeitkonstante der Eingangsschaltung	22 ms	Kopplungsschalter auf AC
Maximal zulässige Eingangsspannung	400 V Gleichspannung + Spitzenwert einer Wechselspannung	
Chopperfrequenz	ca. 250 kHz.	
Vertikale Strahlverschiebung	± 8 Teile	
Maximale Ablenkung	24 Teile	Für sinusförmige Signale mit Frequenzen bis zu 5 MHz
Gleichtaktunterdrückung in A-B Betrieb	100:1 bei 1 MHz	A-B Betrieb mit 8 Teilen des Gleichtaktsignals
Übersprechen zwischen Kanälen	–50 dB oder besser bei 15 MHz	
Instabilität des Leuchtflecks:		
Bildsprung	< 0.3 Teil	Beim Schalten zwischen einer der Abschwächerstellungen oder bei Betätigung anderer Schalter.
Gleichspannungsstabilität	< 1 Teil/Std.	Im gesamten Temperaturbereich

	Bezeichnung	*Beschreibung*	*Nähere Angaben*
1.2.3.	**Zeitablenkung**		
	Zeitkoeffizienten	0.2 s/Teil ... 0.5 μs/Teil	1-2-5 Folge
	Kontinuierlicher Einstellbereich	1: ⩾ 2.5.	Nicht kalibrierte kontinuierliche Einstellung zwischen den 1-2-5 Stufen
	Fehlergrenze des Koeffizienten	± 3 %	
	Dehnung	x5	
	Fehlergrenze der Dehnung	± 2 %	
1.2.4.	**Triggerung**		
	Quelle	Kanal A, Kanal B, extern und Netz	
	Kopplung	Wechselspannungsgekoppelt	
	Triggerungsart	Automatisch oder normal	
	Trigger-Empfindlichkeit	Intern: 0.75 Teil	Signale ⩽ 5 MHz
		1.5 Teil	Signale ⩽ 15 MHz
		Extern: 0,8 V	Signale ⩽ 15 MHz
	Triggerfrequenzbereich	20 Hz ... 15 MHz	Automatischer Freilauf
		10 Hz ... 15 MHz	Normal
	Pegelbereich	Intern: ± 12 Teile	Von Bildschirmmitte
		Extern: ± 6 V	Von Bildschirmmitte
	Triggerflanke	Positif oder negatif gehend	
	Eingangsimpedanz	1 MΩ//25 pF	
	Maximal zulässige Eingangsspannung	400 V, Gleichspannung + Spitzenwert einer Wechselspannung	
	TV-Triggerung	Triggerung von	
		Bildimpulsen (TVF)	TIME/DIV 0.2 s ... 0.5 ms/DIV
		Zeilenimpulsen (TVL)	TIME/DIV 0.2 ms ... 0.5 μs/DIV
			Mit eingeschaltetem TV-Filter arbeitet die Zeitablenkung in Betriebsart AUTO
	TV-Trigger-Empfindlichkeit	intern 0.75 DIV	Synchronimpuls Amplitude
		extern 0.8 V	Synchronimpuls Amplitude
1.2.5.	**X-Ablenkung**		
	Quelle	Zeitablenkung	
		X über Y_B-Betrieb	Mit Schalter TIME/DIV in Stand X via B
	Ablenkkoeffizienten	Kanal B: wie eingestellt mit AMPL/DIV	
	Ablenk-Fehlergrenze	± 15 %	Über Kanal B
	Frequenzbereich	DC: 0 ... 1 MHz (–3 dB)	
	Phasenverschiebung	3^{o} bei 50 kHz	
	Dynamischer Bereich	24 Teile	Für Frequenzen ⩽ 100 kHz
1.2.6.	**Messkopf Kalibrierung**	Ausgangsspannung genügt für Einstellung der Impulswiedergabe von Messköpfen.	

1.2.7. Stromversorgung

Wechselspannungversorgung:	Doppelt isoliert	Die Isolierung entspricht den Anforderungen von IEC 348 für Geräte der Schutzklasse II in Metallgehäusen
Nominaler Spannungsbereich (am Netzspannungsumschalter)	110, 127, 220 oder 240 V Wechselspannung ± 10 %	

Bezeichnung	*Beschreibung*	*Nähere Angaben*
Nominaler Frequenzbereich	46 ... 440 Hz	
Leistungsaufnahme	20 W max.	Bei Netz-Nennspannung

Das Gerät kann mit einer Wahlweise erhältlichen externen 24 V, DC Versorgungseinheit ausgestattet werden (siehe auch 3.4.).

DC Versorgungsspannung	23 V ± 10 %
DC Versorgungsstrom	Die externe Stromquelle muss minimal 1.2 A liefern können.

1.2.8. Einflussgrössen

Die Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die diese Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT. EINDHOVEN, NIEDERLANDE angefordert werden.

Umgebungstemperatur:	
Nominaler Betriebsbereich	+5 °C ... +40 °C
Zugelassener Betriebstemperaturbereich	–10 °C ... +55 °C
Lagerung und Transport	–40 °C ... +70 °C
Höhe	Betriebsfähig : bis 5000 m Nicht betriebsfähig: bis 15000 m
Feuchtigkeit	21 Tagezyklus bei 25 °C ... 40 °C feuchter Wärme, Rel. Feuchtigkeit = 95 %
Stossfestigkeit	30 g: ½ sinusförmiger Stoss, Dauer 11 ms: 3 Stösse in jeder Richtung bei insgesamt 12 Stössen.
Vibration	3 g: Vibrationen in drei Richtungen, maximal 15 Minuten pro Richtung 10 Minuten mit einer Frequenz von 15-25 Hz und einer Amplitude von 1 mm Spitze-Spitze; 5 Minuten mit einer Frequenz von 25-55 Hz und einer Amplitude von 0.5 mm Spitze-Spitze. Einheit befestigt auf Vibrationstisch ohne stossdämpfendes Material.
Erholungszeit	30 Minuten wenn die Temperatur des Gerätes von –10 °C auf +20 °C Raumtemperatur erhöht wird, bei 60 % relativer Luftfeuchtigkeit.
Störgrad	Entspricht den Anforderungen gemäss VDE, Störgrad K.

1.2.9. Mechanische Daten

Abmessungen:		
Länge	550 mm	Einschliesslich Handgriff
Breite	320 mm	Einschliesslich Handgriff
Höhe	150 mm	Einschliesslich Füsse
Gewicht	7,5 kg	

1.3. ZUBEHÖR

1.3.1. Geliefert mit PM 3211

Frontdeckel
BNC - 4 mm Adapter
Handbuch.

1.3.2. Geliefert mit PM 3211Q

Frontdeckel
2 Abschwächer-Tastköpfe PM 9326/40 (Beschreibung, siehe 1.3.3.).
Handbuch.

1.3.3. Kenndaten des Abschwächer-Tastkopfs PM 9326/40

EINLEITUNG

Zwei Tastköpfe dieses Typs werden mit dem PM 3211Q mitgeliefert.
Der passive Abschwächer Testkopf PM 9326/40 besteht aus einem Messkabel mit BNC-Stecker und einem aufsteckbaren Tastkopf. Er eignet sich zur Anwendung bei Oszilloskopen mit einer Bandbreite bis 15 MHz und einem Eingangswiderstand von 1 MΩ.

TECHNISCHE DATEN

Abschwächung	10x, ± 3 %
Eingangswiderstand	10 MΩ, ± 3 %
Eingangskapazität	8 pF, ± 2 pF
Anstiegszeit	7 ns
Kompensationsbereich	10 ... 55 pF
Max. zulässige Eingangsspannung (nur Tastkopf)	1000 V, DC + AC Spitze

Die Toleranzen gelten, wenn der Tastkopf an ein Oszilloskop mit Eingangs-Nennwiderstand angeschlossen ist. Die höchstzulässige Eingangsspannung des Oszilloskops ist sowohl in AC wie in DC Stellung des Eingangskopplungsschalters zu berücksichtigen.

ZUBEHÖR

1 Tastkopfkabel	5322 321 20087
1 Erdkabel	5322 321 20134
1 Tastkopf 10:1	5322 210 70044
1 Testklemme	5322 264 20016
Ferner erhältlich:	
1 Widerstand für Abschwächer-Tastkopf	5322 111 20155

ANPASSUNG DES TASTKOPFS AN DEN OSZILLOSKOPEINGANG

- Durch einstellen der Betriebsart LINE eine Zeitablenklinie darstellen; die Triggerquellenwahltasten A und B gleichzeitig eindrücken.
- Einsteller LEVEL auf AUTO stellen.
- Die Kanal A, AC/DC Drucktaste ausrasten.
- Den Kanal A, AMPL/DIV Schalter auf 5 mV/DIV stellen.
- Den Tastkopf an Kanal A Eingangsbuchse X2 anschliessen und die Tastkopfspitze an Buchse PROBE ADJ. legen.
- Schalter TIME/DIV entweder auf 0.5 ms oder 0.2 ms/DIV stellen.
- Die Verriegelungsschraube des Tastkopfs durch Linksdrehung lösen (Abb. 1.2.).
- Den Tastkopfkörper drehen um die Kapazität zu ändern, zugleich das Bild für die gewünschte Signalform beobachten (Abb. 1.2.).
- Nach Ausführung des Kompensationsverfahrens sorgfältig nach rechts anziehen, ohne dabei die Einstellung zu ändern.

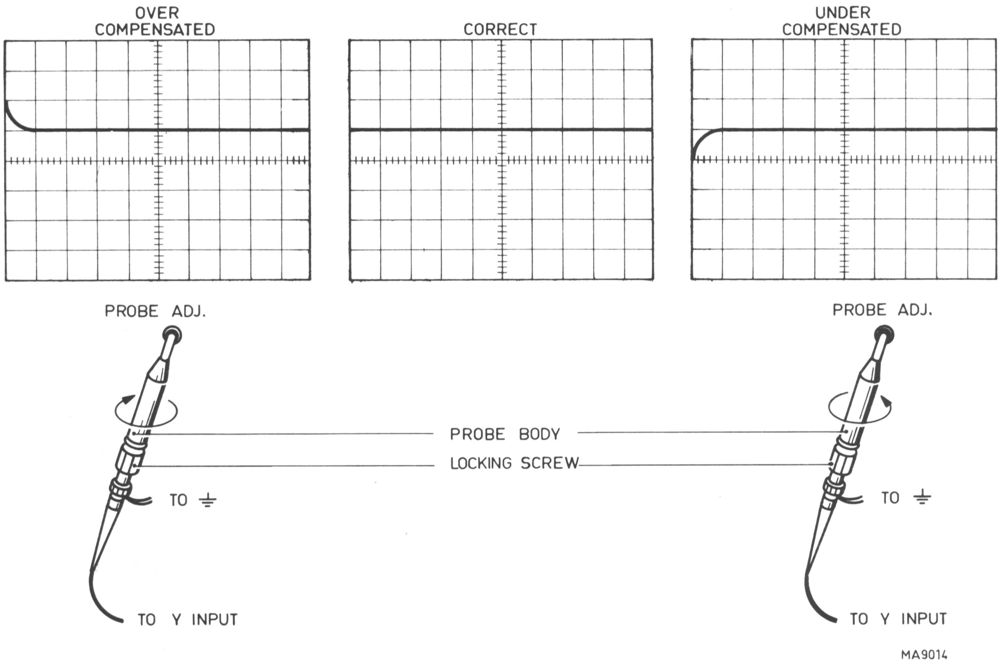


Abb. 1.2. Anpassung des Abschwächer-Tastkopfs PM 9326/40 an den Oszilloskopeingang.

1.3.4. Wahlzubehör

PM 9326 : Passiver Messkopf 1:1/10:1 (1.1 m)
PM 9327 : Passiver Messkopf 1:1/10:1 (2.1 m)
PM 8921 : Passiver Messkopf 1:1 (1.5 m)
PM 8921L : Passiver Messkopf 1:1 (2.5 m)
PM 8925 : Passiver Messkopf 10:1; 11 pF (1.5 m)
PM 8925L : Passiver Messkopf 10:1; 14 pF (2.5 m)
PM 8932 : Passiver Messkopf 100:1; max. Spannung 5600 V; 2 pF (1.5 m)
PM 9353 : Aktiver FET-Messkopf 1:1; 10:1; 3.5 pF
PM 9355 : Strommesskopf 12 Hz ... 70 MHz
PM 9346 : Messkopfspeisung
PM 8910 : Polaroid Anti-Reflexfilter
PM 9380 : Oszillografenkamera
PM 8971 : Kameraadapter
PM 8962 : 19" Gestelleinbau
PM 9366 : Faltbarer Lichtschutztubus
PM 8980 : Geschlossene Lichtschutztubus, lang
PM 8991 : Rolltisch
PM 8992/01 : Zubehörtasche

Bei Anwendung eines Steinheil Adapters 1820/50 ist der Gebrauch von Steinheil Oscillophot ® Kameras M3, M4 und M5 möglich.

1.4. BESCHREIBUNG DES BLOCKSCHALTBILDES (Siehe Abb. 1.3.)

Die Schaltung ist angeordent auf 3 Leiterplatten, welche die folgenden Schaltungsteile enthalten:

a. Haupteinheit : Vertikalstufen ausgenommen Endverstärker (final amplifier).
Triggerung, Zeitablenkung und Horizontalvorverstärker , Bilddrehung (TRACE ROTATION).

b. Endverstärkereinheit : Vertikaler Endverstärker (FINAL Y-AMPL)
Horizontaler Endverstärker (FINAL X-AMPL)
Z-Verstärker

c. Speiseeinheit (POWER SUPPLY)

Das Blockschaltbild ist Abb. 1.3. zu entnehmen. Die Beschriftung der Blöcke ist in englischer Sprache. Diese englischen Termen finden Sie neben den deutschen angegeben in dieser Anleitung. Es ist zu beachten dass dieses Blockschaltbild nicht den verschieden Leiterplatten entsprechend unterteilt ist, sondern nach den vier Funktionen, nl.: vertikales-, horizontales-, Bild-Teil und Speisung.

1.4.1. Vertikalablenkung

Da A und B Kanal nahezu identisch sind wird nur ein Kanal beschrieben. Das an der Eingangsbuchse anliegende Signal wird direkt oder über einen DC Sperrkondensator – je nach Stellung des Kopplungsschalters AC/DC – der hochohmigen Abschwächerstufe (HIGH IMPEDANCE ATTEN.) zugeführt. Durch Eindrücken der Drucktaste "0" wird der Abschwächereingang geerdet. Der hochohmige Abschwächer (HIGH IMPEDANCE ATTEN.) der die Abschwächkoeffizienten 100, 10 und 1 umfasst von einer Vorverstärkerstufe (PRE-AMPLIFIER) gefolgt. Dieser Vorverstärker enthält folgende Funktionen:

- Die Abschwächerfolge 1-2-5.
- Eine zehnfache Verstärkung für die drei empfindlichsten Stellungen des Schalters AMPL/DIV.
- Die Gleichgewichtseinstellung (BAL X1).
- Den Verstärkungseinsteller GAIN (nur für Kanal A).
- Die Funktion INVERT zur Polaritätsumkehrung von Kanal B.
- Den Bildlage-Einsteller (POSITION).

Der Vorverstärker (PREAMPLIFIER) besitzt zwei Ausgänge, einer davon speist den Triggerabnahme- (TRIGG. PICK OFF) Verstärker. Der andere Ausgang speist den mit CHANNEL SWITCH (Kanalschalter) bezeichneten Block. Dieser Kanalschalter ermöglicht – abhängig von einem Befehlssignal – Durchschaltung des Vorverstärker-Ausgangssignals zum Vertikal-Endverstärker (FINAL Y AMPL). Letzterer speist die Vertikalablenkplatten der Elektronenstrahlröhre (CRT). Die Befehlssignale für beide Kanalschalter werden vom Kanal Multivibrator (CHANNEL MULTIVIB.) erzeugt, der mit den Drucktasten Kanal A ON/OFF, Kanal B ON/OFF, CHOP/ALT und ADD gesteuert wird. Für die alternierende Betriebsart (ALT) wird ein der Zeitablenkung entnommenes Signal angewandt. Es sind folgende Betriebsarten möglich:

- Einkanalbetrieb: Ein Kanal wird stufenlos zum Y-Endverstärker durchgeschaltet, während der andere Kanal gesperrt ist.
- Alternierender Zweikanalbetrieb (ALT): Der Y-Endverstärkereingang wird am Ende der Zeitablenkung von einem Kanal auf den anderen umgeschaltet.
- Gechoppter Zweikanalbetrieb (CHOP): Der Y-Endverstärkereingang wird mit einer Festfrequenz von 500 kHz von einem auf den anderen Kanal umgeschaltet.
- Addiert (ADD): Beide Kanäle werden gleichzeitig zum Y-Endverstärker durchgeschaltet und eine Summierung beider Kanäle findet statt.
- Differentielle Betriebsart: Wie Betriebsart "added", aber Kanal B invertiert.

1.4.2. Triggerung und Horizontalablenkung

Die Signalquelle an welcher die Zeitablenkung triggern muss wird mit dem Triggerquelle-Wahlschalter (TRIGG. SOURCE SELECT.) gewählt. Mit diesem Block lassen sich folgende Triggerquellen einstellen:

- Die Triggerabnahme Verstärker, Kanal A oder Kanal B (CH.A TRIGG PICK OFF und CH. B TRIGG PICK OFF) die mit Drucktasten A und B betätigt werden.
- Der externe Trigger Verstärker (EXT TRIGG AMPL) zum Triggern auf ein an den externen Eingang (X5) anliegendes Signal. Diese Möglichkeit lässt sich durch Eindrücken der Taste EXT bewirken.
- Ein Signal von der Netzspannung (LINE), wenn Drucktasten A und B zugleich eingedrückt werden.

Das gewählte Triggersignal wird dem Eingang des +/– Flankenwählers (SLOPE SELECTOR), der Triggerung auf der positiv oder negativ gerichteten Flanke erlaubt, zugeführt. Dieser Block bewirkt, je nach Stellung der Drucktaste +/– eine Phasenverschiebung von 180° beziehungsweise 360°.

Der Flankenwähler (SLOPE SELECTOR) speist die Triggervergleichsschaltung (TRIGGER COMPARATOR). Dieser Block ermöglicht Einstellung des Triggersignalpegels an welchem die Zeitablenkung ausgelöst wird. Triggerung auf einem einstellbaren Pegel wird von Steller LEVEL ermöglicht und in Betriebsart AUTO wird Triggerung am Spitzenwert des Triggersignals möglich. Sowohl Steller LEVEL wie auch Schalter AUTO werden mit dem gleichen Knopf betätigt.

Das TV-Filter, welches an den Komparatorausgang angeschlossen ist gestattet Triggerung auf Bild- (TVF) oder Zeilenimpulsen (TVL).
Die Wahl von Zeilen- oder Bildimpulsen ist von der Einstellung des Schalters TIME/DIV der Zeitablenkung abhängig (Siehe Abschnitt 2.2.3.).

Wenn die Sperrschaltung (HOLD OFF CIRCUIT) ein Freigabesignal abgibt startet die SWEEP GATING LOGIC nach Erhalt eines vom TRIGGER COMPARATOR kommenden Triggerbefehls die Zeitablenkung (TIME BASE).

Die Sperrschaltung (HOLD OFF CIRCUIT) verhindert ein Ansprechen der Sweep-gate Schaltung auf einen Triggerbefehl bevor der Zeitablenkungkondensator vollständig entladen ist.
Es gibt zwei Sperrzeiten, die von der Einstellung des Schalters TIME/DIV bestimmt werden und zwar eine für die langsamen (0,2 s/DIV ... 0,5 ms/DIV) und eine für die schnellen (0,2 ms/DIV ... 0,5 μs/DIV) Ablenkzeiten.
Beim Umschalten von der langsamen Ablenkung auf Sperrzeit der schnellen Ablenkung wird das TV FILTER von Bild- (TVF) auf Zeilenimpulseinstellung (TVL) umgeschaltet.

Die Sweep-gating Logik verfügt ausser über den Ausgang der die Zeitablenkung schaltet auch über einen Ausgang der den Kanal-Multivibrator (CHANNEL MULTIVIBRATOR) speist so dass die vertikale alternierende (ALT) Darstellungsart möglich wird.
Ein dritter Ausgang wird zur Steuerung des Z-Verstärkers verwendet für die Austastung des Bildes während des Rücklaufs der Zeitablenkung.

Die Zeitbasis (TIME BASE) erzeugt einen Sägezahn der für die Horizontalablenkung benutzt wird. Die Ablenkzeit ist mit dem stufenweisen Steller TIME/DIV einstellbar. Der Steller VARIABLE TIME/DIV ermöglicht Einstellung der Ablenkzeiten zwischen den Stufen von TIME/DIV.

Der Quellenwähler für Horizontalablenkung (X DEFL. SELECT) wählt das Eingangssignal für den X-Endverstärker (FINAL X-AMPL). Bei normalen Zeitablenkbetrieb wird der Sägezahn gewählt.
Bei Betriebsart X via B wird ein Ausgangssignal des Kanal B Triggerabnahme (CH. B TRIGG. PICK OFF) Verstärkers gewählt.

Der X-Endverstärker (FINAL X-AMPL) welcher die Horizontalablenkplatten der Elektronenstrahlröhre (CRT) steuert verfügt über einen Einsteller der horizontalen Lage (X-POSITION). In diesem Knopf ist ein Zugschalter PULL FOR X5 einbezogen mit dem eine 5-fache Dehnung der Horizontalablenkung bewirkt wird.

1.4.3. Bildteil

Der Z-Verstärker (Z-AMPLIFIER) erhält ein Eingangs-Austastsignal, kommend von SWEEP GATING LOGIC und vom Kanal-Multivibrator (CHANNEL MULTIVIB.). Die Strahlaustastung erfolgt während des Rücklauf der Zeitablenkung und bei gechoppter Betriebsart während des Umschaltens von einem Kanal zum anderen.
Der Einsteller INTENS bestimmt die in den Z-Verstärker gelangende Stromenge.

Das Ausgangssignal des Z-Verstärkers (Z-AMPLIFIER) muss an die Steuerelektroden der Elektronenstrahlröhre (CRT), deren Potential −2 kV beträgt, gelangen. Zwei Sperrkondensatoren werden zur Trennung der Z-Ausgang Gleichspannung von der −2 kV Spannung der Elektronenstrahlröhre angewandt. Die HF-Komponente im Z-Ausgangssignal wird über den einen Sperrkondensator dem Wehneltzylinder der Elektronenstrahlröhre zugeführt.
Die NF- und Gleichspannungskomponenten werden mit Hilfe eines Modulatorblocks (MODULATOR) auf ein 200 kHz Trägersignal moduliert, welches durch den zweiten Sperrkondensator übertragen wird. Dieser Kondensator speist einen DEMODULATOR der seinerseits den Wehneltzylinder der Elektronenstrahlröhre speist.

Der Bilddrehungsblock (TRACE ROTATION) der mittels einer Schraubenziehereinstellung auf der Frontplatte bedient wird, gestattet die Stromeinstellung (Stärke und Richtung) durch die Bilddrehungsspule der Elektronenstrahlröhre. Diese Vorrichtung ermöglicht Ausrichtung der Zeitablenklinien mit den horizontalen Rasterlinien. Rasterlinien.

1.4.4. Stromversorgung

Netztransformator und Gleichrichter (MAINS TRANSF. +RECTIFIER): die Netzspannung (LINE VOLTAGE) wird mit Hilfe eines doppelt isolierten Transformators gewandelt und danach auf 46 V Gleichspannung gleichgerichtet. Diese Gleichspannung wird einem reguliertem Umsetzer (REGULATED DC TO AC CONVERTER) zugeführt. Dieser Umsetzer erzeugt eine regulierte Rechteckspannung von etwa 16 kHz die an den HF-Transformator und Gleichrichter- (HF. TRANSF + RECTIFIER) Block gelangt. Dieser Block stellt mehrere Ausgangs-Gleichspannungen zur Speisung der verschiedenen Teile des Geräts zur Verfügung.

2. Gebrauchsanleitung

2.1. INBETRIEBNAHME

2.1.1. Sicherheitsvorschriften (den IEC 348 Bedingungen entsprechend)

Vor Anschluss des Geräts ist eine Sichtkontrolle des Geräts vorzunehmen, um festzustellen ob das Gerät möglicherweise während des Transports beschädigt wurde. Wenn irgend welche Defekte wahrgenommen werden darf das Gerät nicht an das Netz angeschlossen werden.
Vor Wartungs- oder Reparaturarbeiten ist das Gerät von allen Stromquellen zu trennen und müssen alle Hochspannung führenden Teile entladen sein. Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft, die die damit verbundenen Gefahren kennt, geschehen. In Normalbetrieb erübrigt die doppelte Isolierung der Stromversorgung die Notwendigkeit einer Schutzerde.

WARNUNG: **Es ist zu beachten dass bei allen Messungen die Gehäuseerde die gleiche Spannung wie die Messköpferde erreicht.
Weder die Messköpferdleitung noch die Gehäuseerde dürfen mit berührungsgefährlichen Spannungen verbunden werden.**

2.1.2. Örtlicher Netzanschluss und Sicherung

Vor dem Anschliessen an das Netz ist zu prüfen, ob das Gerät für die örtliche Netzspannung eingestellt ist. Das Gerät wird eingestellt für 220 V geliefert. Falls das Gerät mit einem 110 V, 127 V oder 240 V Netz verwendet wird, ist die geeignete Netzspannung mit Hilfe des Spannungsumschalters an der Geräterückwand so einzustellen dass er die erforderliche Spannung anzeigt (siehe Abb. 2.1.). Bevor diese Einstellung vorgenommen wird muss das Gerät vom Netz getrennt werden. Das Gerät ist gegen Überlastungen durch eine auf der Netzteil-Leiterplatte angebrachte Sicherung 500 mA, flink (F801) und durch eine Thermosicherung geschützt. Letztere befindet sich im Transformator zum Schutz gegen übermässig hohe Temperaturen um zu verhindern das die doppelte Isolierung beschädigt wird.

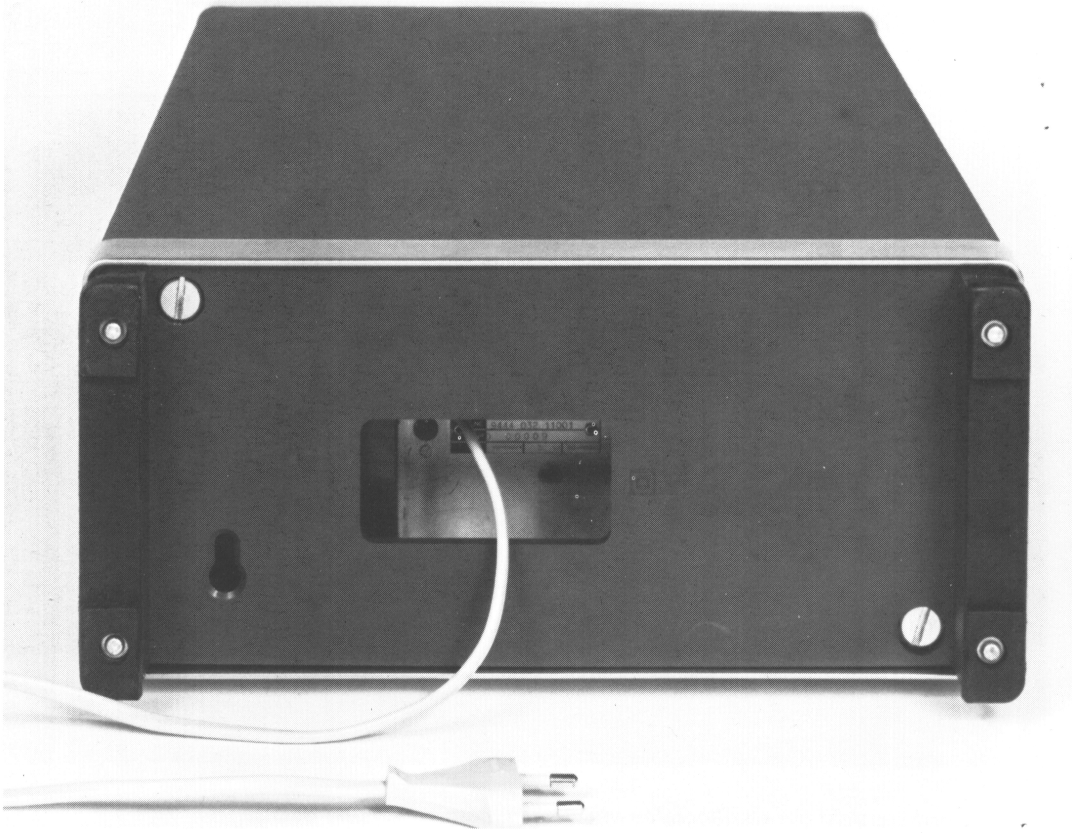


Abb. 2.1. Rückansicht des Oszillografen

2.1.3. Anschluss an eine externe Versorgungsspannung 24 V, DC

Das Gerät kann mit einer wahlweise erhältlichen externen 24 V, DC Versorgungseinheit ausgestattet werden. Die externe Versorgung oder Batterie von 23 V (± 10 %) die zumindest 1.2 A liefern können muss, kann an die Buchse an der Geräterückwand angeschlossen werden (z.B. über den Gleichspannungs-Versorgungskabelsatz 4822 321 20125). Der Innenleiter der Buchse muss an den Minuspol, der Aussenleiter an den Pluspol angeschlossen werden. Der externe Gleichspannungswandler ist durch eine 2 A Sicherung gegen Überlast geschützt. Diese Sicherung kann nach Abnehmen des Mantels vom Gerät ersetzt werden. Nähere Einzelheiten sind in Abschnitt 3.4. gegeben.

2.1.4. Abdeckhaube und Betriebslage

Die Abdeckhaube lässt sich auf eine einfache Weise durch Ziehen von der Gerätefront abnehmen. Das Gerät darf in waagrechter Lage oder mit Gebrauch des Tragsbügel als Kippbügel in verschiedenen Schrägstellungen aufgestellt werden. Um den Tragbügel zu entriegeln (press to unlock carrying handle), gleichzeitig die beiden Lagerzapfenknöpfe eindrücken. (Siehe Abb. 2.2.).

2.2. BEDIENUNGSELEMENTE UND BUCHSEN (Siehe Abb. 2.2.)

2.2.1. Bildteil und Netzschalter

INTENS/POWER ON	Stufenlose Einstellung der Bildhelligkeit; zugleich Netzschalter. Signallampe zeigt Betriebszustand (ON) an.
FOCUS	Stufenlose Einstellung zur Fokussierung des Elektronenstrahls.
TRACE ROTATION	Schraubenzieheneinstellung zur Ausrichtung der Schreibspur mit den horizontalen Rasterlinien.

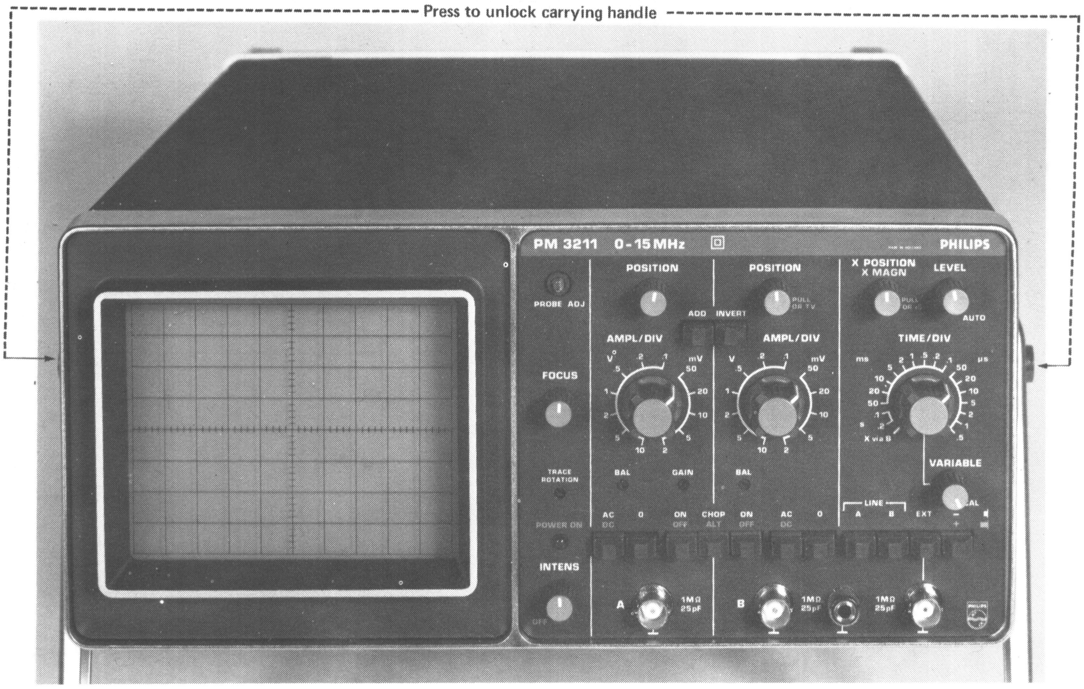


Abb. 2.2. Vorderansicht des Oszillografen mit Bedienungsorganen und Buchsen

2.2.2. Vertikalablenkung

A	BNC-Buchse für Kanal A Eingang
B	BNC-Buchse für Kanal B Eingang
AC/DC	Wenn eingedrückt: Kopplung über einen Sperrkondensator Wenn ausgelöst : Direkte Kopplung
0	Wenn eingedrückt: Verbindung zwischen Eingangsschaltung und Eingangsbuchse ist unterbrochen und die Eingangsschaltung ist geerdet.
ON/OFF CH. A	Ein/aus Kanal A: das an Buchse A gelegte Signal wird dargestellt wenn diese Taste gedrückt wird.
ON/OFF CH. B	Ein/aus Kanal B: das an Buchse B gelegte Signal wird dargestellt wenn diese Taste gedrückt wird. Wenn keine der beiden Tasten eingedrückt ist wird nur ein Kanal dargestellt. Welcher Kanal wird dabei nicht bestimmt.
CHOP/ALT	Wenn sowohl Kanal A wie Kanal B auf ON stehen, können sie in gechoppter (CHOP) oder in alternerender (ALT)Betriebsart dargestellt werden. ALT: Das Bild wird am Ende jedes Zyklus des Zeitablenksignals von einem Vertikalkanal auf den anderen umgeschaltet. CHOP: Das Bild wird mit einer Festfrequenz von einem Vertikalkanal auf den anderen umgeschaltet ($f \approx 500$ kHz).
INVERT CH. B	Das Kanal B Signal wird nach Drücken dieser Taste invertiert.
ADD	Vertikalablenkung durch die Summe der Signale von Kanal A und B.
AMPL/DIV	Stufenweise Einstellung der Vertikalablenkkoeffizienten, von 2 mV/DIV bis zu 10 V/DIV in 1-2-5 Folge.
POSITION	Stufenlose Einstellung der vertikalen Verschiebung des Bildes.
BAL. CH. A (CH. B)	Diese Schraubenziehereinstellung (Frontplatte) ist für einen minimalen Schreibspursprung beim Umschalten des CH. A (CH. B) AMPL/DIV Knopfes von 2 auf 5 mV/DIV eingestellt.
GAIN CH. A	Mit dieser Scharaubenziehereinstellung (Frontplatte) wird die Verstärkung von Kanal A an die von Kanal B angeglichen. Dies ist notwendig um in Betriebsart A-B den vorgeschriebenen Gleichtaktunterdrückungsfaktor zur erlangen (näheres siehe Abschnitt 2.3.7.).

2.2.3. Zeitablenkung

TRIGGERQUELLE	A	Wenn diese Taste gedrückt ist kann die Zeitablenkung auf ein Kanal A entnommenes Signal triggern.
	B	Wenn diese Taste gedrückt ist kann die Zeitablenkung auf ein Kanal B entnommenes Signal triggern.
	LINE	Wenn die beiden Kanal A und Kanal B Triggerquellen-Drucktasten gedrückt sind, kann die Zeitablenkung auf ein Signal von der Netzspannung (LINE) triggern.
	EXT	Wenn diese Taste gedrückt ist kann die Zeitablenkung auf ein Signal vom externen Triggereingang triggern.
Keine Taste gedrückt		In diesem Falle triggert die Zeitablenkung auf ein Signal das Kanal A entnommen ist.
LEVEL		Ermöglicht Einstellung des Triggersignalpegel bei welchem die Zeitablenkung startet.

AUTO	Dies ist die Endstellung der LEVEL Einstellung. In dieser Stellung triggert die Zeitablenkung automatisch am Spitzenpegel des Triggersignals. Ausserdem ist die Zeitablenkung freilaufend wenn kein Triggersignal vorhanden ist.
+/– SLOPE	Ermöglicht Triggerung auf der positiv (Taste ausgelöst) oder negativ (Taste eingedrückt) gerichteten Flanke des Triggersignals.
TIME/DIV	Wählt den Zeitkoeffizient von 0.5 µs/DIV bis 0.2 s/DIV in 1-2-5 Folge. In Stellung X VIA B wird die Horizontalablenkung vom Kanal B Eingangssignal bestimmt.
VARIABLE TIME/DIV	Stufenlose Einstellung des Zeitkoeffizienten zwischen den TIME/DIV Stufen. Muss sich in Stellung CAL befinden damit die Zeitachse gemäss der Anzeige des Schalters TIME/DIV kalibriert ist.
PULL FOR TV	Das TV-Filter wird durch Ziehen des Knopfes **POSITION**, Kanal B eingeschaltet. Ausserdem arbeitet die Zeitablenkung dann in Betriebsart AUTO. Triggerung von Bildimpulsen (TVF) wird mit TIME/DIV Schalter im Bereich 0.2 s ... 0.5 ms/DIV bewirkt. Triggerung von Zeilenimpulsen (TVL) wird mit TIME/DIV Schalter im Bereich 0.2 ms ... 0.5 µs/DIV bewirkt. Die +/– SLOPE Taste dient zur Einstellung des Geräts für positive und negative Videosignale.

2.2.4. Horizontalablenkung

TIME/DIV X VIA B	Wenn sich der Schalter TIME/DIV in einer der Stellungen zwischen 0.2 s/DIV und 0.5 µs/DIV befindet wird die Horizontalablenkung vom Zeitbasisgenerator bewirkt. Wenn sich Schalter TIME/DIV in Stellung X VIA B befindet bewirkt das an den Kanal B Eingang gelegte Signal die Horizontalablenkung. Bei dieser Betriebsart muss Kanal B ausgeschaltet (S13 ausgerastet) und Kanal A eingeschaltet (S11 gedrückt) sein, um nur Horizontalablenkung zu erlangen.
X POSITION PULL FOR X5	Stufenlose Einstellung der horizontalen Lage des Bildes; einbezogen ein Zug-Druckschalter mit dem sich die Horizontalablenkung um den Faktor 5 vergrössern lässt.

2.2.5. Übrige

PROBE ADJ	Ausgangsbuchse an der eine Spannung zur Verfügung steht, die für die Einstellung der Impulswiedergabe von Abschwächer Messköpfen hinreichend ist (siehe Abschnitt 1.33 und 2.35).
LINE (MAINS) VOLTAGE ADAPTER	Muss anhand der Angaben in Abschnitt 2.1.2. eingestellt werden bevor das Gerät an die örtliche Netzspannung angeschlossen wird.

2.3. BEDIENUNGSANLEITUNG

2.3.1. Einschalten des Geräts

Vor Anschluss des Geräts an eine Stromquelle sind die in Abschnitt "Inbetriebnahme" gegebenen Anleitungen genauestens auszuführen.

Das Gerät wird normalerweise nach einer Anwärmzeit von etwa 15 Minuten den Spezifikationen (siehe Abschnitt 1.2.) entsprechen. Wenn das Gerät jedoch grösser Kälte ausgesetzt war (z.B. unter Frostbedingungen nachts im Auto gelassen) und danach in einen warmen Raum gebracht wird, ist eine Anwärmzeit von etwa einer halben Stunde einzuhalten (siehe Abschnitt 1.2.8.).

2.3.2. **Vorbereitende Einstellungen** (POS CH.A, POS CH. B, X POS, INTENS, FOCUS)

Mit diesem Verfahren lässt sich feststellen ob der Oszillograf ordnungsgemäss funktioniert und es ergibt einen tauglichen Ausgangspunkt für den Beginn von Messungen.
Siehe Abb. 2.2. bezüglich der Lage der Bedienungselemente. Bringe die Einsteller INTENS und FOCUS in Mittelstellung. Taste AUTO drücken und mit Schalter TIME/DIV einen durchschnittlichen Zeitkoeffizienten zwischen 10 μs/DIV und 10 ms/DIV wählen. Mit allen übrigen Drucktasten in Normalstand (nicht gedrückt) lassen sich die Schreibstrahlspuren von Kanal A und Kanal B mit dem entsprechenden Einsteller POSITION auf dem Bildschirm darstellen.

Mit Bedienungselement INTENS eine mittlere Bildhelligkeit und mit FOCUS eine gute Strahlfokussierung einstellen.

2.3.3. **Eingangskopplung** (AC/DC, 0)

AC-Kopplung (Drucktaste eingedrückt) dient zum Sperren der Gleichspannungskomponente eines Signals.
Die AC Einstellung unterdrückt die Niederfrequenzen, wodurch sinusförmige Signale niedriger Folgefrequenz abgeschwächt werden und Rechtecksignale niedriger Folgefrequenz verformt werden. Der Abschwächungsgrad wird von der Eingangs RC-Zeit (22 ms) bestimmt.
Eingangs RC-Zeit wird 10-fach erweitert wenn 10:1 passive Messköpfe verwendet werden.
Wenn auf AC-Kopplung geschaltet wird dauert es etwa fünf Eingangs RC-Zeiten bevor der Strahl auf den Mittelwert des Eingangssignals stabilisiert ist.
AC-Stellung Messungen können nicht gegenüber Erde vorgenommen worden.

In **Stellung 0** wird das Eingangssignal unterbrochen und der Verstärkereingang kurzgeschlossen, dies zur Ermittlung des Nullpegels.

DC-Kopplung (Drucktaste normal) ermöglicht Frequenzeingang über den gesamten Bereich, dass heisst bis hinab auf Gleichspannung.

2.3.4. **Anwendung von Messköpfen**

1:1 passive Messköpfe sollten nur für Gleichspannung und Niederfrequenzen eingesetzt werden.
Kapazitive Belastung schwächt hohe Frequenzen ab oder erhöht die Anstiegszeit von Messignalen (abhängig von Quellimpedanz).
10:1 passive Messköpfe besitzen eine kleinere kapazitive Belastung; gewöhnlich etwa 10 pF bis 20 pF.
FET-Messköpfe sind besser, besonders wenn Messungen von Messpunkten mit hoher Impedanz vorgenommen oder and der oberen Frequenzgrenze der Bandbreite des Oszillografen ausgeführt werden sollen.
10:1 passive Messköpfe müssen vor Gebrauch ordnungsgemäss kompensiert werden. Ungenaue Kompensation hat Impulsverformung oder Amplitudenfehler bei hohen Frequenzen zur Folge.
Für genaue Einstellung kann der PROBE ADJ -Ausgangsanschluss verwendet werden (siehe Abb. 2.3.).

2.3.5. **Abgleich von Abschwächer-Messköpfen PM 8925, PM 8925L und PM 8932** (PROBE ADJ. Buchse)

- Betriebsart LINE Triggerung wählen (Drucktasten A und B gleichzeitig drücken) und eine Zeitablenklinie darstellen.
- Einsteller LEVEL ganz nach rechts drehen (Stellung AUTO).
- Taste AC/DC des A Kanals (S9) in Stellung DC.
- Schalter AMPL/DIV des A Kanals (S5) auf 5 mV/DIV stellen.
- Die Kompensationsdose mit Buchse A (X2) verbinden und die Messkopfspitze an den Anschluss PROBE ADJ legen.
- Schalter TIME/DIV (S7) auf 0,5 ms oder 0,2 ms/DIV stellen.
- Mit einem kleinen Schraubenzieher durch die Öffnung der Kompensationsdose den Trimmer so einstellen, dass eine richtige Darstellung erhalten wird (siehe Abb. 2.3.).

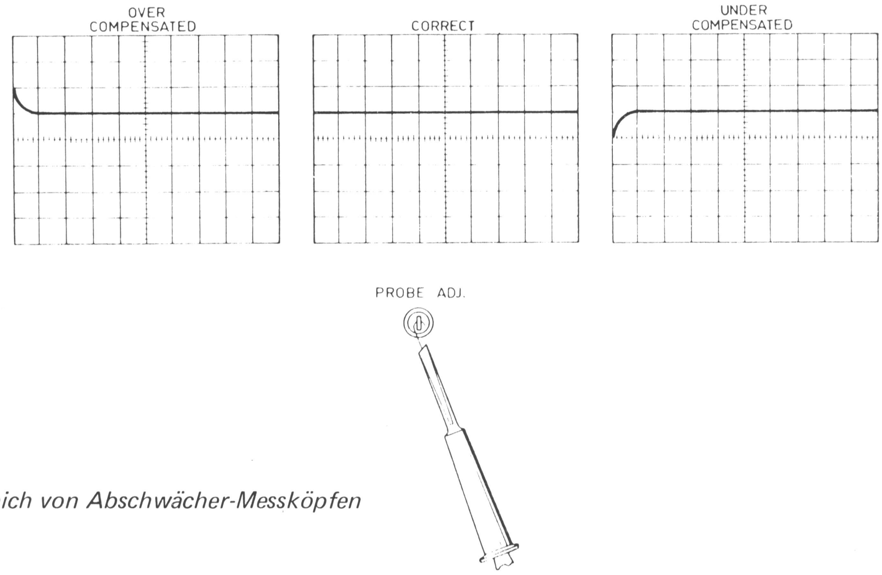


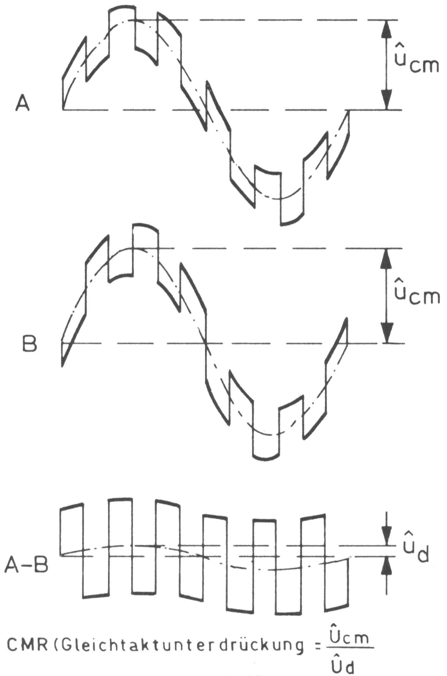
Abb. 2.3. Abgleich von Abschwächer-Messköpfen

2.3.6. **Wahl der gechoppten oder der alternierenden Darstellungsart** (CHOP/ALT)

Im Zweikanalbetrieb muss für relative lange Ablenkzeiten von 0,2 s/DIV... 0,1 ms/DIV oder bei vorkommender niedriger Ablenk-Folgefrequenz selbst bei kurzen Ablenkzeiten, die Darstellungsart CHOP verwendet werden (CHOP/ALT Schalter eingedrückt). Stellung ALT würde unter diesen Umständen Vergleiche zwischen Signalformen erschweren da sonst die beiden Signale gesondert wahrgenommen würden.
Wenn die Darstellung jedoch schnell genug ist um von der Chopperfrequenz unterbrochen zu werden muss die alternierenden Darstellungsart eingestellt werden (CHOP/ALT ausgelöst); gewöhnlich bei Ablenkzeiten schneller als 0.1 ms/DIV.

2.3.7. **Differentielle Betriebsart** (ADD, CH. B INVERT, CH. A GAIN)

Betriebsart A-B lässt sich durch Drücken der Tasten ADD und INVERT einstellen. Bei Messungen wobei Signalleitungen bedeutende Gleichtaktsignale führen (z.B. Brumm) hebt die differentielle Betriebsart diese Signale auf, und lässt den Rest (A-B), der von Bedeutung ist, übrig. Die Fähigkeit des Oszillografen für Unterdrückung von Gleichtaktsignalen ist vom CMR-Faktor gegeben (siehe Abb. 2.4.). Um den spezifizierten Grad der Gleichtaktunterdrückung zu erlangen müssen erst die Kanal A und B Verstärkungen ausgeglichen werden. Dies wird durch Anschluss beider Kanäle an das gleiche Signal und durch Einstellung von CH. A GAIN (Schraubenziehereinstellung auf der Frontplatte) auf minimum-Ablenkung am Bildschirm erreicht.
Bei Verwendung von passiven 10:1 Messköpfen ist ein ähnliches Ausgleichverfahren zu empfehlen und zwar durch ihre Kompensationseinstellung auf Minimum-Ablenkung zu bringen.



CMR (Gleichtaktunterdrückung $= \frac{\hat{U}_{cm}}{\hat{U}_d}$

Wie hier dargestellt CMR≈ 10

Abb. 2.4. Gleichtaktunterdrückung

MA 9818

2.3.8. **Wahl der Triggerquelle** (A, B, LINE, EXT)

Der Triggerquellenwähler ermöglicht die Wahl des Signal mit dem die Zeitablenkung triggern kann.
Die Triggerquelle kann sein:

- **A oder B:** Triggerung erfolgt nach Erhalt eines Signals vom vertikalen Kanal A oder Kanal B Eingangssignal. Bei Vergleichung von Signalformen die ein Vielfaches ihrer Frequenz sind, immer das Signal mit der niedrigsten Folgefrequenz als Triggersignal wählen. Wenn nicht, könnten Doppelbilder (gechopped) oder Falsche Zeitverschiebungen (alternierend) entstehen.
- **LINE:** Netztriggerung ist nützlich wenn das zu messende Signal netzfrequenzbezogen ist.
- **EXT:** Falls mehrere Signale abgetastet werden, ist es günstig ein externes Signal zur Triggerung zu benutzen. Bei einer Änderung des Eingangssignals ist Einstellung und Neueinstellung der Trigger-Bedienungselemente (LEVEL, SLOPE und SOURCE) nicht nötig. Ausserdem bleiben die beiden Eingänge A und B für Untersuchungen der Signalformen verfügbar.
- Wenn keine Taste gedrückt ist triggert die Zeitablenkung auf ein von Kanal A kommendes Signal.

Der Triggerwähler ist wechselspannungsgekoppelt. Dadurch ändert sich der Pegel bei dem die Darstellung startet bei Veränderung des Mittelwerts des Triggersignals. Der Triggerpegel ist folglich nicht mehr auf Signalerde bezogen. Dies kann bei Signalformen die im Zeitabstand von Zyklus zu Zyklus variieren Instabilität zur Folge haben. Wenn dies unerwünscht ist, umschalten auf Betriebsart AUTO um Spitzenpegel-Triggerung zu erlangen.

2.3.9. **Wahl der Triggerart** (AUTO, LEVEL SLOPE)

Betriebsart AUTO (Steller LEVEL auf Rechtsanschlag) ist äusserst nützlich da in ihr, selbst wenn keine Triggersignale vorhanden sind, eine Schreibspur(en) auf dem Schirm sichtbar wird, weil die Zeitablenkung 100 ms nach dem letzen Triggersignal freiläuft.

In Betriebsart AUTO erfolgt die Triggerung an der Spitze des Triggersignals. Für Signale mit niedrigen Folgefrequenzen von 20 Hz oder niedriger lässt sich Betriebsart AUTO nicht verwenden weil dann die Zeitablenkung in Freilaufbetrieb gelangen würde. In solchen Fällen ist die normale Triggerart zu wählen. Steller LEVEL nicht in Stellung AUTO und entsprechend eingestellt.

Mit Drucktaste +/– SLOPE wird die positive oder negative Flanke des Triggersignal für die Triggerung der Zeitablenkung gewählt.

2.3.10. **X VIA B Betriebsart** (TIME/DIV)

X VIA B Messungen werden mit Schalter TIME/DIV in Stellung X VIA B vorgenommen.
X VIA B Messungen ergeben ein zweckmässiges Mittel für Frequenz- oder Phasenverschiebungsvergleiche durch Darstellung mit Lissajous Figuren.
Messungen bis zu 50 kHz sind möglich wobei der Phasenfehler zwischen Horizontal- und Vertikalkanal geringer ist als 3^{o}.
Die X-Empfindlichkeit = AMPL/DIV CH. B, ± 15 %.

2.4. AUSBAU VON SICHERUNGEN, SCHIRMRAHMEN, KONTRAST UND RASTERPLATTE

2.4.1. Abnehmen der Geräte-Abdeckungen.

Vor dem Abnehmen der Abdeckungen des Geräts muss dieses vom Netz getrennt werden.

- Den Tragegriff in eine derartige Stellung bringen, dass das Gerät auf seiner Frontschutzhaube auf einer ebenen Fläche stehen kann.
- Die beiden Schlitzschrauben an der Rückwand lösen.
- Die Rückwand abnehmen.
- Den Mantel abheben.
- Damit die Frontplatte zugänglich wird, das Gerät waagrecht aufstellen und die Frontschutzhaube abziehen.

2.4.2. Ersetzen der Thermosicherung F802

- Die Geräte-Abdeckungen wie in Abschnitt 2.4.1. beschrieben abnehmen.
- Die Plastikschutzhaube des Netzteils entfernen.
  Diese Schutzhaube besitzt 4 in die rechteckigen Öffnungen der Metallrückwand passenden Klemmen zu ihrer Befestigung.
  Die Schutzhaube lässt sich abnehmen indem man ihre Seiten an den Stellen wo sich die Klemmen befinden eindrückt und die Schutzhaube vorsichtig von der Rückwand zieht.
- Ersetzen des Sicherungselements (siehe Abb. 2.5.).
  Die Netzdrähte an der Sicherungsseite des Transformators ablöten und entfernen.
  Die Anschlussdrähte der Sicherung ablöten.
  Das Sicherungsgehäuse mit Hilfe eines kleines Schraubenziehers etwas auswärts biegen um den Sperrnocken zu lösen. Nun die Sicherung vorsichtig aus ihrem Gehäuse ziehen.
- Einbau eines neuen Sicherungselements.

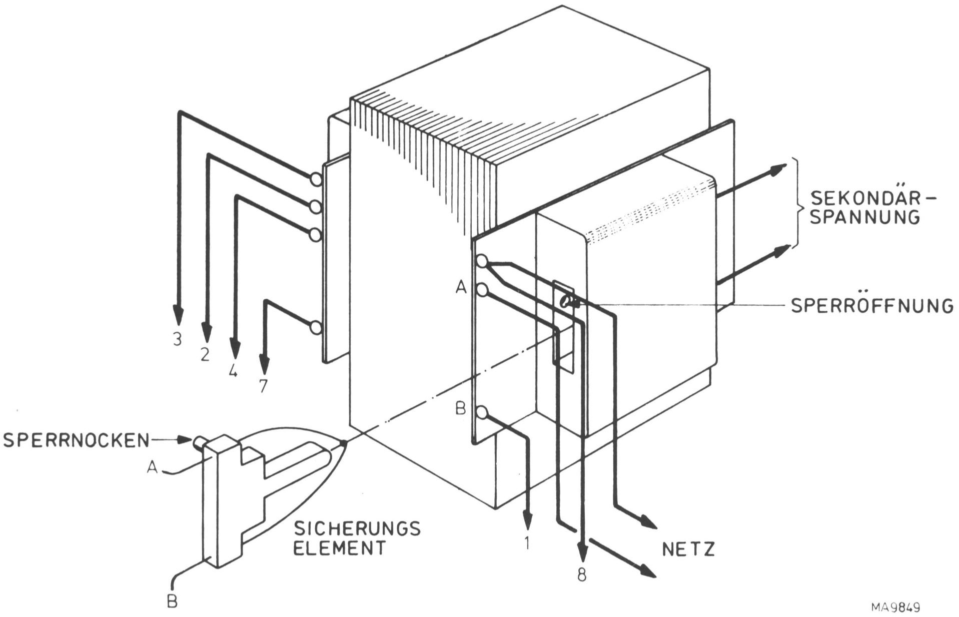


Abb. 2.5. Netztransformator und Lage der Thermosicherung.
Die Ziffern beziehen sich auf die Stiftziffern des Netzspannungsadaptors.

Eine neue Sicherung nehmen und sie auf die oben beschriebene Weise aus ihrem Gehäuse ziehen. Das neue Element in das Gehäuse der alten Sicherung im Transformator schieben bis der Sperrnocken in der Sperröffnung einrastet.

- Sicherungsdrähte und Netzdrähte wieder anlöten.

2.4.3. Ersetzen der Sicherung F801

- Die Geräteabdeckungen wie in Abschnitt 2.4.1. angegeben abnehmen.
- Sicherung F801 (500 mA, flink) die sich auf der Netzteil-Leiterplatte befindet austauschen.

2.4.4. Ausbau von Schirmrahmen und Kontrastplatte (Siehe Abb. 2.6.)

- Den Schirmrahmen an seinen unteren Ecken festhalten und so von der Frontplatte abziehen.
- Das Kontrastfilter kann nun vorsichtig aus dem Rahmen gedrückt werden.

2.4.5. Ausbau der Rasterplatte

- Mit dem Fingernagel oder einem kleinen Schraubenzieher zwischen Rasterplatte und dem Schirm der Elektronenstrahlröhre vorsichtig etwas Raum machen.
- Diesen Abstand nun soweit vergrösseren dass sich die linke Seite der Rasterplatte aus dem Frontprofil nehmen lässt.
- Nach Abnahme der linken Seite lässt sich die Rasterplatte entfernen.
- Einbau der Rasterplatte:
  Erst die rechte Seite und dann die linke Seite einbauen.

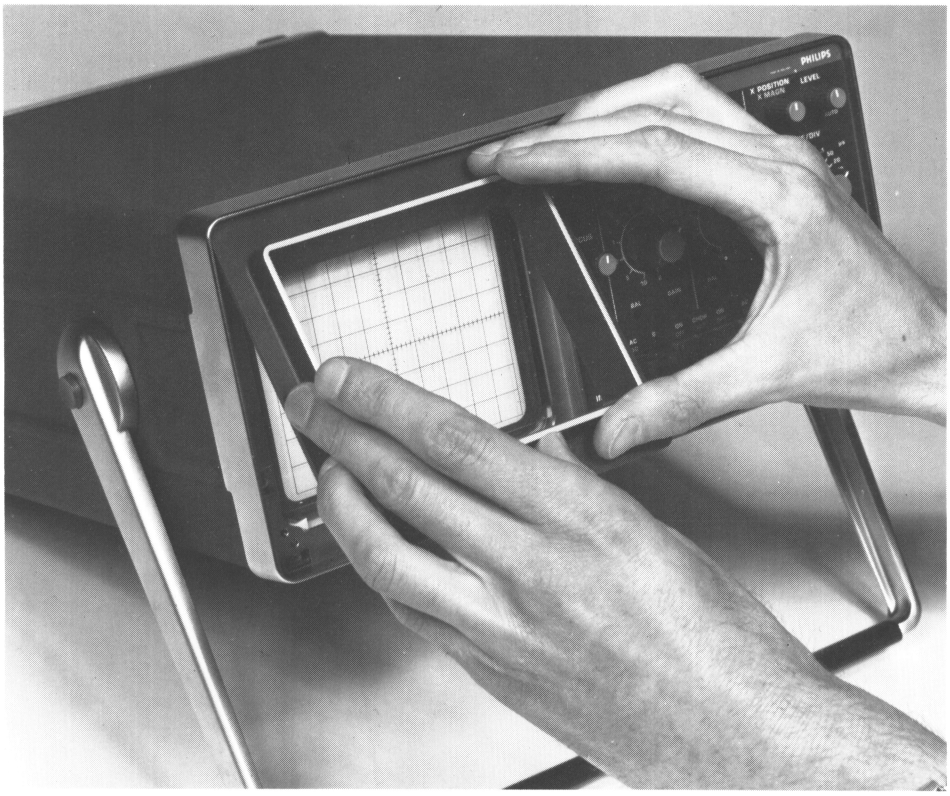


Abb. 2.6. Ausbau von Schirmrahmen und Kontrastplatte

Notice d'emploi

1. Généralités

1.1. INTRODUCTION

L'oscilloscope à double trace PM 3211 est un instrument compact et léger, de conception ergonomique: il a été conçu à des fins de service, de recherche et d'enseignement.

L'appareil présente une sensibilité de 2 mV/DIV, une largeur de bande de 15 MHz et un écran de 8 x 10 cm à forte intensité de trace. Il offre de nombreuses possibilités d'affichage: monovoie, deux voies en mode alterné ou découpé ou deux voies additionnées. La voie B peut être affichée en mode normal ou inverse.

L'appareil est équipé de plusieurs sortes de déclenchement y compris le déclenchement TV.

Une alimentation à double isolement permet de connecter le châssis directement à des circuits de terre flottants, à condition qu'ils ne présentent pas de tension dangereuse au toucher.
De plus, il y a réduction substantielle du parasitage par les courants de terre, dont sont fréquemment affectés les oscilloscopes mis à terre.

Le PM 3211Q est la version américaine de l'appareil de base PM 3211. Contrairement à ce dernier, le PM 3211Q est livré avec deux sondes 10:1 PM 9326/40.

ATTENTION: **La masse du châssis (et le câble de masse de sonde) ne doivent pas être connectés à des circuits sous tension dangereuse au toucher.**

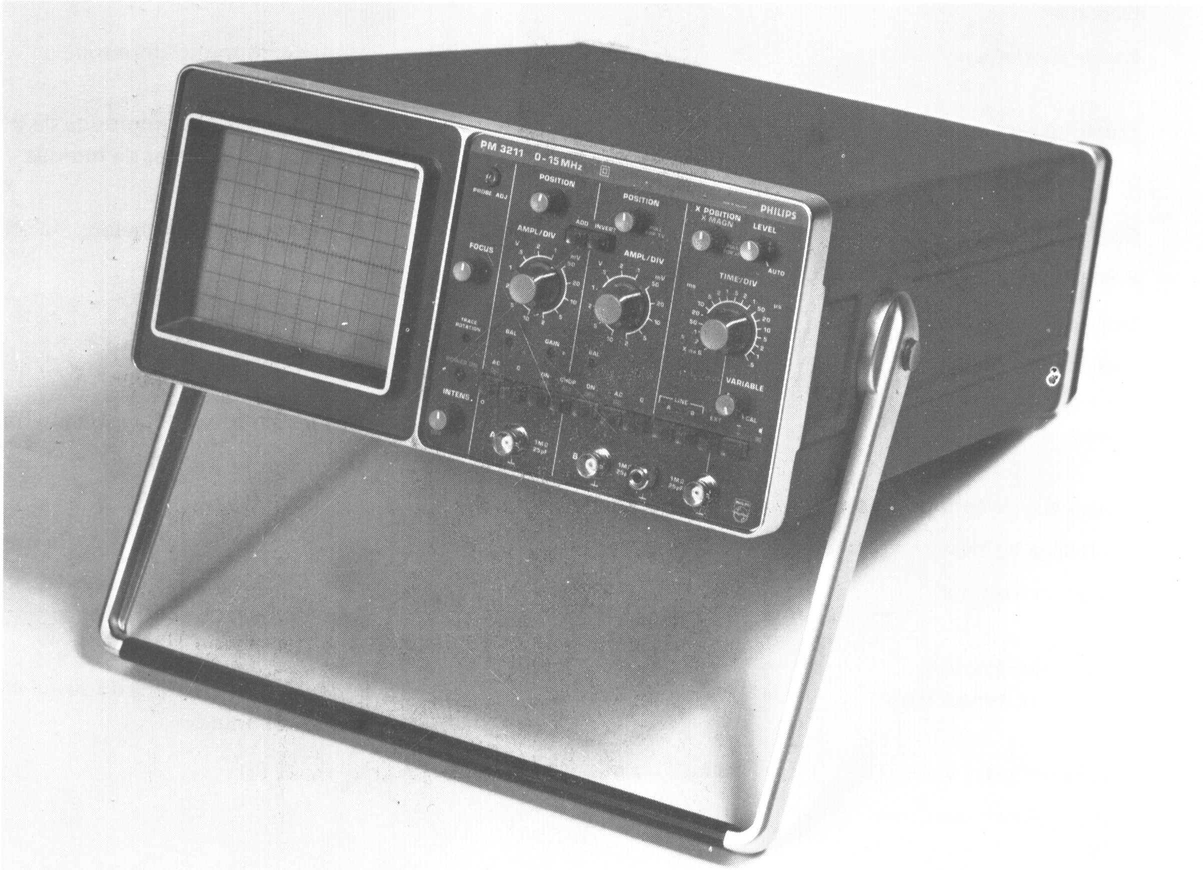


Fig. 1.1. Oscilloscope 15 MHz à double trace PM 3211

1.2. CARACTERISTIQUES TECHNIQUES

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe II. A sa livraison il répond aux règles de sécurité. La présente notice comporte les informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme. Sauf indications contraires, les propriétés exprimées en valeurs numériques tolérancées sont garanties pour des températures ambiantes comprises entre +5 °C et +40 °C. Les valeurs numériques non tolérancées sont des valeurs normales et représentent les caractéristiques d'un instrument moyen.

	Désignation	*Spécification*	*Renseignements supplémentaires*
1.2.1.	**Tube à rayons cathodiques**		
	Type	D14-260GH	
	Surface utile de l'écran	8 x 10 divisions	1 division égale 1 cm
	Type d'écran	P31 (GH) standard	P7 (GM) en option
	Tension totale d'accélération	4 kV	
	Graticule	Externe	
1.2.2.	**Amplificateur vertical**		
	Modes d'affichage	Voie A seulement Voie B seulement A et B découpées A et B alternées A et B ajoutées	
	Couplage d'entrée	AC, DC, 0	
	Polarité de la voie B	Normale ou inversée	
	Réponse:		
	Bande passante	DC: 0 Hz ... 15 MHz (–3 dB) AC: 10 Hz ... 15 MHz (–3 dB)	Mesurée pour une amplitude de 6 divisions.
	Précision de mesure	⩽ ± 3 %	Mesurée pour une amplitude de 6 divisions et un temps de montée ⩾ 3 ns
	Coefficients de déviation	2 mV/DIV ... 10 V/DIV	Progression 1-2-5, échelons étalonnés
	Précision de déviation	± 3 %	
	Impédance d'entrée	1 MΩ//25 pF	
	Temps d'entrée RC	22 ms	Couplage capacitif (AC)
	Tension maximale admissible d'entrée	400 V	Tension continue + tension alternative crête.
	Fréquence de commutation	Environ 250 kHz	
	Décradage vertical	± 8 divisions	
	Déviation maximal	24 divisions	Pour signaux sinusoïdaux avec fréquences jusqu'à 5 MHz
	Facteur de réjection en mode commun (A-B)	100 : 1 à 1 MHz	Mode A-B, 8 divisions du signal en mode commun.
	Diaphonie entre voies	–50 dB ou mieux à 15 MHz	
	Instabilité de la position du spot:		
	Saut de trace	< 0,3 DIV	En commutant entre les positions d'atténuator ou en actionnant d'autres commutateurs.
	Stabilité en continu	< 1 DIV/heure	Sur tout la gamme de température

	Désignation	*Spécification*	*Renseignements supplémentaires*
1.2.3.	**Base de temps**		
	Coefficients de temps	0,2 s/DIV ... 0,5 µs/DIV	progression 1-2-5
	Gamme de réglage continue	1:⩾ 2,5	Commande continue non-étalonnée entre les échelons 1-2-5
	Précision	± 3 %	
	Agrandissement	5x	
	Erreur d'agrandissement supplémentaire	± 2 %	
1.2.4.	**Déclenchement**		
	Source	Voie A, voie B, externe et fréquence secteur	
	Couplage	Capacitif (AC)	
	Mode de déclenchement	Automatique, normal	Mode automatique combiné au niveau supérieur de déclenchement
	Sensibilité de déclenchement	Interne: 0,75 DIV	Signaux ⩽ 5 MHz
		1,5 DIV	Signaux ⩽ 15 MHz
		Externe: 0,8 DIV	Signaux ⩽ 15 MHz
	Gamme de fréquence de déclenchement	20 Hz ... 15 MHz	libre automatique
		10 Hz ... 15 MHz	normal
	Gamme de niveau	interne: ± 12 DIV	par rapport au centre de l'écran
		externe: ± 6 DIV	par rapport au centre de l'écran
	Pente	+ ou –	
	Impédance d'entrée	1 MΩ//25 pF	équivalent à l'impédance des entrées verticales
	Tension maximale d'entrée	400 V	tension continue + tension alternative crêt
	Déclenchement TV	Déclenchement sur	
		tension de trame (TVF)	TIME/DIV 0,2 s ... 0,5 ms/DIV
		tension de ligne (TVL)	TIME/DIV 0,2 ms ... 0,5 µs/DIV
			Avec le filtre TV, la base de temps fonctionne en mode AUTO.
	Sensibilité de déclenchement TV	interne 0,75 DIV	Amplitude d'impulsion de synchron
		externe 0,8 V	Amplitude d'impulsion de synchron
1.2.5.	**Déviation X**		
	Source	Base de temps	
		X via Y_B	Commutateur TIME/DIV en position X via B
	Coefficients de déviation	Voie B: suivant la position de AMPL/DIV	
	Précision	± 15 %	Via voie B
	Gamme de fréquence	Coupage direct: 0 ... 1 MHz (– 3 dB)	
	Déphasage	3^o à 50 kHz	
	Gamme dynamique	24 divisions	Pour fréquences ⩽ 100 kHz
1.2.6.	**Etalonnage des sondes**	Tension de sortie suffisante au réglage la réponse d'impulsion des sondes	

1.2.7. Alimentation

Tension alternative	à double isolement	Classe de sécurité II, IEC 348
Tensions nominales (sur le carrousel)	110, 127, 220 ou 240 V a.c. ± 10 %	
Gamme de fréquence nominale	46 ... 440 Hz	
Consommation	20 W max.	A la tension secteur nominale

L'appareil peut être équipé d'une option pour alimentation externe 24 V continu (voir section 3.4.):

Tension d'alimentation en continu	23 V, ± 10 %
Courant d'alimentation en continu	La source d'alimentation doit être capable de fournir un courant d'au moins 1,2 A.

1.2.8. Conditions ambiantes

Les données relatives aux conditions ambiantes ne sont valables que si l'instrument est contrôlé conformément aux méthodes officielles. Des renseignements sur ces méthodes et sur les critères employés sont fournis sur demande par l'organisation Philips de votre pays ou par le TEST AND MEASURING DEPARTMENT de la N.V. PHILIPS' GLOEILAMPENFABRIEKEN à EINDHOVEN, PAYS-BAS.

Désignation	*Spécification*	*Renseignements supplémentaires*
Temperature ambiante:		
Gamme de référence d'utilisation	+5 °C ... +40 °C	
Gamme limite d'utilisation	−10 °C ... +55 °C	
Conditions de stockage et de transport	−40 °C ... +70 °C	
Altitude	En fonctionnement : jusqu'à 5000 m Hors fonctionnement: jusqu'à 15000 m	
Humidité	Vapeur humide 25 °C - 40 °C, 21 jours	R.H. = 95 %
Chocs	30 g: demi-sinus, durée 11 ms; 3 chocs dans chaque direction, total 12 chocs.	
Vibration	3 g: dans trois directions, durée 15 min. max. par direction; 10 min. à fréquence 15 - 25 Hz et amplitude 1 mm crête-à-crête; 5 min. à fréquence 25 - 55 Hz et amplitude 0,5 mm c-c. Unité montée sur table vibrante sans absorption de chocs.	
Temps de rétablissement	30 minutes si la température de l'instrument passe de −10 °C à +20 °C sous humidité relative de 60 %.	
Interférence électromagnétique	Conforme à VDE, Störgrad K.	

1.2.9. Caractéristiques mécaniques

Dimensions:

Longueur	550 mm	Poignée comprise
Largeur	320 mm	Poignée comprise
Hauteur	150 mm	Pied compris
Poids	7,5 kg	

1.3. ACCESSOIRES

1.3.1. Fournis avec le PM 3211

Couvercle avant
Adaptateur BNC - 4 mm banane
Notice d'emploi et d'entretien

1.3.2. Fournis avec le PM 3211Q

Couvercle frontal.
2 Sondes atténuatrices PM 9326/40 (Description, voir 1.3.3.).
Notice d'emploi et d'entretien.

1.3.3. Caractéristiques techniques de la sonde atténuatrice PM 9326/40

INTRODUCTION

Deux sondes de ce type sont comprises à la livraison du PM 3211Q.
La sonde atténuatrice passive PM 9326/40 consiste en un câble de mesure avec connecteur BNC et une sonde enfichable, à utiliser avec des oscilloscopes avec largeur de bande jusqu'à 15 MHz et résistance d'entrée de 1 MΩ.

CARACTERISTIQUES TECHNIQUES

Atténuation	10x, ± 3 %
Résistance d'entrée	10 MΩ, ± 3 %
Capacité d'entrée	8 pF, ± 2 pF
Temps de montée	7 ns
Gamme de compensation	10 ... 55 pF
Tension d'entrée maxi admise (sonde uniquement)	1000 V, continu + crête alternative.

Les tolérances s'appliquent lorsque la sonde est connectée à un oscilloscope avec résistance d'entrée nominale. Cependant, il faut tenir compte de la tension d'entrée maximale admise de l'oscilloscope en position AC et DC du commutateur de couplage d'entrée.

ACCESSOIRES

1 câble de sonde	5322 321 20087
1 câble de terre	5322 321 20134
1 sonde 10:1	5322 210 70044
1 pince de mesure	5322 264 20016
également disponible:	
1 résistance pour sonde atténuatrice	5322 111 20155

REGLAGE DE LA SONDE ATTENUATRICE A L'ENTREE D'OSCILLOSCOPE

- Représenter une ligne de base de temps en choisissant le mode LINE; enfoncer simultanément les boutons-poussoirs A et B du sélecteur de source de déclenchement.
- Mettre la commande LEVEL en position AUTO.
- Relâcher le bouton-poussoir AC/DC de la voie A.
- Mettre le commutateur AMPL/DIV en position 5 mV/DIV.
- Connecter la sonde à la douille d'entrée X2 de la voie A et mettre la pointe de la sonde sur la douille PROBE ADJ.
- Mettre le commutateur TIME/DIV en position 0,5 ms ou 0,2 ms/DIV.
- Dévisser l'écrou de verrouillage de sonde en le tournant vers la gauche (voir Fig. 1.2.).
- Tourner le corps de sonde afin de changer la capacité tout en observant l'affichage ou la forme d'onde requise (voir Fig. 1.2.).
- Lorsque la compensation est réalisée, tourner prudemment l'écrou de verrouillage vers la droite pour le serrer sans dérégler.

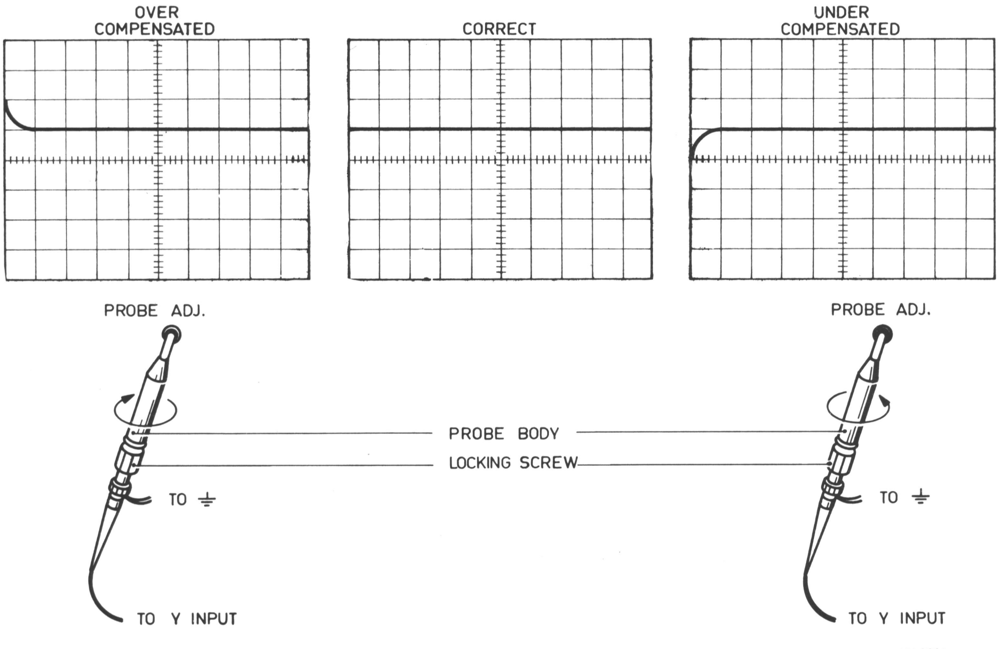


Fig. 1.2. Réglage de la sonde atténuatrice PM 9326/40 à l'entrée d'oscilloscope

1.3.4. En option

PM 9326 : Sonde passive 1:1/10:1 (1,1 m)
PM 9327 : Sonde passive 1:1/10:1 (2,1 m)
PM 8921 : Sonde passive 1:1 (1,5 m)
PM 8921L : Sonde passive 1:1 (2,5 m)
PM 8925 : Sonde passive 10:1 (1,5 m), 11 pF
PM 8925L : Sonde passive 10:1 (2,5 m), 14 pF
PM 8932 : Sonde passive 100:1, tension maxi 5600 V, 2 pF (1,5 m)
PM 9353 : Sonde active à FET 1:1; 10:1; 3,5 pF
PM 9355 : Sonde de courant 12 Hz ... 70 MHz
PM 9346 : Alimentation de sonde active
PM 8910 : Filtre Polaroid
PM 9380 : Caméra d'enregistrement
PM 8971 : Adaptateur pour PM 9380
PM 8962 : Adaptateur pour montage en rack 19"
PM 9366 : Visière repliable
PM 8980 : Visière longue
PM 8991 : Table roulante
PM 8992/01 : Malette pour accessoires

Les caméras **Steinheil Oscillophot** Ⓡ M3, M4 et M5 sont applicables à condition d'utiliser l'adaptateur Steinheil 1820/50.

1.4. DESCRIPTION DU SCHEMA SYNOPTIQUE (Voir Fig. 1.3.).

Trois platines imprimées forment le circuit et contiennent les éléments suivants:

a. Unité principale : étages verticaux (excepté d'amplificateur de sortie), déclenchement, base de temps et rotation de trace.

b. Unité amplificateur de sortie : amplificateur de sortie vertical, amplificateur de sortie horizontal, amplificateur Z.

c. Unité d'alimentation.

Les textes sur le schéma synoptique Fig. 1.3. sont en langue anglaise. Aussi, pour faciliter la lecture de la description de ce schéma, les termes français sont suivis des termes anglais correspondants, lesquels sont mentionnés entre parenthèses.
De plus, le schéma synoptique n'est pas divisé dans les parties introduites sur les différents circuits imprimés. En effet, le schéma est divisé en quatre parties fonctionnelles: vertical, horizontal, affichage et alimentation.

1.4.1. Déviation verticale

Etant donné que les voies A et B sont pratiquement identiques, une seule voie sera décrite dans le présent texte. Le signal à la douille d'entrée est appliqué directement ou par le condensateur de blockage continu (selon la position du commutateur de couplage AC/DC). Dès que le bouton-poussoir "0" est enfoncé, l'entrée d'atténuateur est mise à la terre. L'atténuateur haute impédance (HIGH IMPEDANCE ATTENUATOR) qui présente les coefficients d'atténuation 100, 10 et 1, est suivi par un étage préamplificateur (PREAMPLIFIER). Ce dernier comprend les fonctions suivantes:

- La progression 1-2-5 d'atténuateur.
- Une augmentation de gain X10 pour les trois positions les plus sensibles du commutateur AMPL/DIV.
- Le réglage BALANCE (BAL X1).
- Le réglage GAIN (uniquement voie A).
- La fonction inverse (INVERT) de la voie B.
- La commande POSITION.

Le préamplificateur (PREAMPLIFIER) présente deux sorties dont l'une alimente le préamplificateur de déclenchement (TRIGGER PICK OFF). L'autre sortie alimente le bloc marqué CHANNEL SWITCH (commutateur de voies). Ce dernier est capable, en fonction d'un signal de commande, de commuter la sortie de préamplificateur à l'amplificateur de sortie Y (FINAL Y AMPLIFIER). Celui-ci alimente les plaques de déviation verticale du tube à rayons cathodiques (CATHODE RAY TUBE/CRT).
Les signaux de commande pour les deux commutateurs de voies sont produits par le multivibrateur de voies (CHANNEL MULTIVIBRATOR), commandé par les boutons-poussoirs CH. A ON/OFF, CH. B ON/OFF, CHOP/ALT et ADD. En mode alterné (ALTERNATE) un signal d'entrée dérivé de la base de temps est utilisé. Les modes suivants sont possibles:

- Fonctionnement monovoie: une voie est commutée de façon continue à l'amplificateur de sortie Y tandis que l'autre voie est bloquée.
- Fonctionnement double voie en mode alterné (ALT): l'entrée de l'amplificateur de sortie Y est commutée d'une voie à l'autre en fin de balayage de la base de temps.
- Fonctionnement double voie en mode cécoupé (CHOP): l'entrée d'amplificateur de srotie Y est commutée d'une voie à l'autre à la fréquence fixe de 500 kHz.
- Fonctionnement en mode additionné (ADD): les deux voies sont commutées simultanément à l'amplificateur de sortie Y et additionnées.
- Fonctionnement en mode soustrait: identique au mode additionné, avec voie B inversée.

1.4.2. Déclenchement et déviation horizontale

La source de signal sur laquelle la base de temps doit déclencher est sélectionnée à l'aide du sélecteur de source de déclenchement (TRIGGER SOURCE SELECTOR). Ce bloc peut sélectionner les sources suivantes:

- Les préamplificateurs de déclenchement voie A ou B (CH. A ou CH. B TRIGGER PICK OFF AMPLIFIER) actionnés par les boutons-poussoirs A et B.
- Le préamplificateur de déclenchement externe (EXTERNAL TRIGGER PREAMPLIFIER) pour déclencher sur un signal appliqué à l'entrée externe (X5). A cet effet, le bouton-poussoir EXT est enfoncé.
- Un signal dérivé de la tension secteur, en enfonçant les boutons A et B simultanément.

Le signal de déclenchement sélectionné est appliqué à l'entrée du sélecteur de pente +/– (+/– SLOPE SELECTOR), de sorte que le déclanchement est possible respectivement sur la pente positive ou négative de ce signal. On obtient ainsi, en fonction de la position du bouton +/–, un déphasage de 180 ou 360°.

Le sélecteur de pente (SLOPE SELECTOR) alimente le bloc comparateur de déclenchement (TRIGGER COMPARATOR), lequel permet de régler le niveau auquel la base de temps démarre.
Le déclenchement sur niveau variable est possible à l'aide de la commande LEVEL et au sommet du signal de déclenchement en mode AUTO. Ces deux commandes (LEVEL et AUTO) sont comprises en un seul bouton.

Le filtre TV connecté à la sortie du comparateur permet de déclencher les impulsions trame (TVF) et ligne (TVL). La sélection des impulsions ligne ou trame dépend de la position du commutateur TIME/DIVde la base de temps. Voir section 2.2.3.

Si le circuit de blocage (HOLD OFF CIRCUIT) donne un signal prêt, le circuit logique de déverrouillage (SWEEP GATING LOGIC) démarre la base de temps (TIME BASE) à la réception de la commande de déclenchement du comparateur de déclenchement (TRIGGER COMPARATOR).

Le circuit de blocage (HOLD OFF CIRCUIT) fait en sorte que le circuit de déverrouillage ne réponde pas à la commande de déclenchement avant que le condensateur de la base de temps soit complètement déchargé.
Il y a deux temps de blocage, fonction du réglage de commutateur TIME/DIV: un pour les temps de balayage lents et l'autre pour les temps de balayage rapides.

Pour passer du temps de blocage lent au temps rapide, le filtre TV (TV FILTER) est réglé sur ligne (TVL) au lieu de trame (TVF).

Le circuit logique de déverrouillage présente, en plus de la sortie commutant la base de temps, une sortie qui alimente le multivibrateur de voies (CHANNEL MULTIVIBRATOR) afin de permettre le mode d'affichage vertical alterné (ALTERNATE).
Une troisième sortie sert à commander l'amplificateur Z (Z AMPLIFIER) afin de supprimer la trace pendant le retour de la base de temps.

La base de temps (TIME BASE) produit une impulsion en dents de scie pour la déviation horizontale. Le temps de balayage peut être réglé à l'aide de la commande en échelons TIME/DIV.
La commande continue variable TIME/DIV permet de régler les temps de balayage entre les échelons de la commande TIME/DIV.

Le sélecteur de source de déviation X (X DEFLECTION SOURCE SELECTOR) sélectionne le signal d'entrée pour l'amplificateur de sortie X (FINAL X AMPLIFIER). En mode de base de temps normale, la dent de scie est sélectionnée. En mode X via B, un signal de sortie du préamplificateur déclenchement voie B est sélectionné.
L'amplificateur de sortie X (FINAL X AMPLIFIER), lequel actionne les plaques de déviation horizontale du tube à rayons cathodiques, offre une commande X POSITION. Le bouton est combiné avec un agrandisseur de base de temps (PULL FOR X5), pour agrandir 5 fois le gain horizontal.

1.4.3. Section affichage TRC

L'amplificateur Z (Z AMPLIFIER) reçoit un signal de suppression du multivibrator de voies et le circuit logique de déverrouillage (SWEEP GATING LOGIC). La suppression de la trace a lieu pendent le retour de la base de temps et en mode découpé pendant le passage d'une voie à l'autre. La commande INTENS détermine la quantité de courant vers l'amplificateur Z.

Le signal de sortie de l'amplificateur Z doit atteindre les électrodes de commande du TRC, lesquelles présentent un potentiel de -2 kV. Deux condensateurs de blocage servent à séparer la tension continue à la sortie Z de la tension TRC de -2 kV. La composante haute fréquence dans le signal de sortie Z est conduite par un condensateur de blocage au cylindre Wehnelt du TRC. Les composantes basse fréquence et continue sont modulées par l'unité modulator (MODULATOR) sur une porteuse de 200 kHz transférée par le second condensateur de blocage. Ce condensateur alimente un démodulateur (DEMODULATOR), qui à son tour alimente le cylindre Wehnelt du TRC.

L'unité de rotation de trace (TRACE ROTATION) actionnée par une commande tournevis au panneau avant, permet de régler le courant (intensité et sens) par la bobine de rotation de trace du TRC.
De la sortie il est possible d'aligner la ligne de base de temps et les lignes de graticule horizontal.

1.4.4. Alimentation

Transformateur secteur + rectificateur (MAINS TRANSFORMER + RECTIFIER): la tension secteur (LINE VOLTAGE) est transformée par un transformateur secteur à double isolation pour être ensuite rectifiée à 46 V continu. Cette tension continue est appliquée au convertisseur continu-alternatif (REGULATED DC TO AC CONVERTER). Ce convertisseur fournit une tension rectangulaire réglée d'environ 16 kHz appliquée au bloc transformateur haute fréquence et rectificateurs (H.F. TRANSFORMER + RECTIFIERS). Ce bloc offre plusieurs tensions de sortie continues en vue de l'alimentation de plusieurs parties de l'appareil.

2. Mode d'emploi

2.1. INSTALLATION

2.1.1. **Règlements de sécurité** (conformes à la IEC 348)

Avant de brancher l'instrument sur le secteur, examiner le coffret, les commandes, les connecteurs, etc. pour s'assurer qu'il n'y a pas eu de dommages en cours de transport. Si l'on constate des défauts, ne pas brancher l'instrument.

Il faut déconnecter l'instrument de toute source de tension et décharger les points sous haute tension avant d'effectuer aucun travail d'entretien ou de réparation. Si les réglages ou l'entretien ne peuvent se faire autrement que sur l'instrument en marche, couvercles déposé, le travail devra être confié à un spécialiste conscient des risques encourus. L'alimentation étant à double isolement, il n'est pas nécessaire de mettre l'appareil à la terre en fonctionnement normal.

ATTENTION: **Il ne faut pas oublier qu'en cours de fonctionnement la masse du châssis de l'oscilloscope est portée au même potentiel que la connexion de terre de la sonde de mesure. Ni le câble de masse de la sonde, ni le châssis ne doivent être connectés à des sources de tension dangereuse au toucher.**

2.1.2. Branchement sur le secteur et fusibles

Avant de brancher l'appareil sur le secteur, s'assurer qu'il est réglé sur la tension correcte. A sa livraison, l'instrument est réglé sur 220 V. S'il doit être utilisé sur du 110 V, 127 V ou 220 V, il faut l'adapter en modifiant la position du carrousel sur le panneau arrière (voir Fig. 2.1.). Avant de procéder à cette modification débrancher l'appareil du secteur. L'appareil est protégé contre les surcharges à l'aide d'un fusible rapide 500 mA (F801) — sur le circuit imprimé alimentation — et d'un fusible thermique. Ce dernier monté dans le transformateur secteur le protège contre de trop hautes températures évitant par le même l'endommagement de la double isolation.

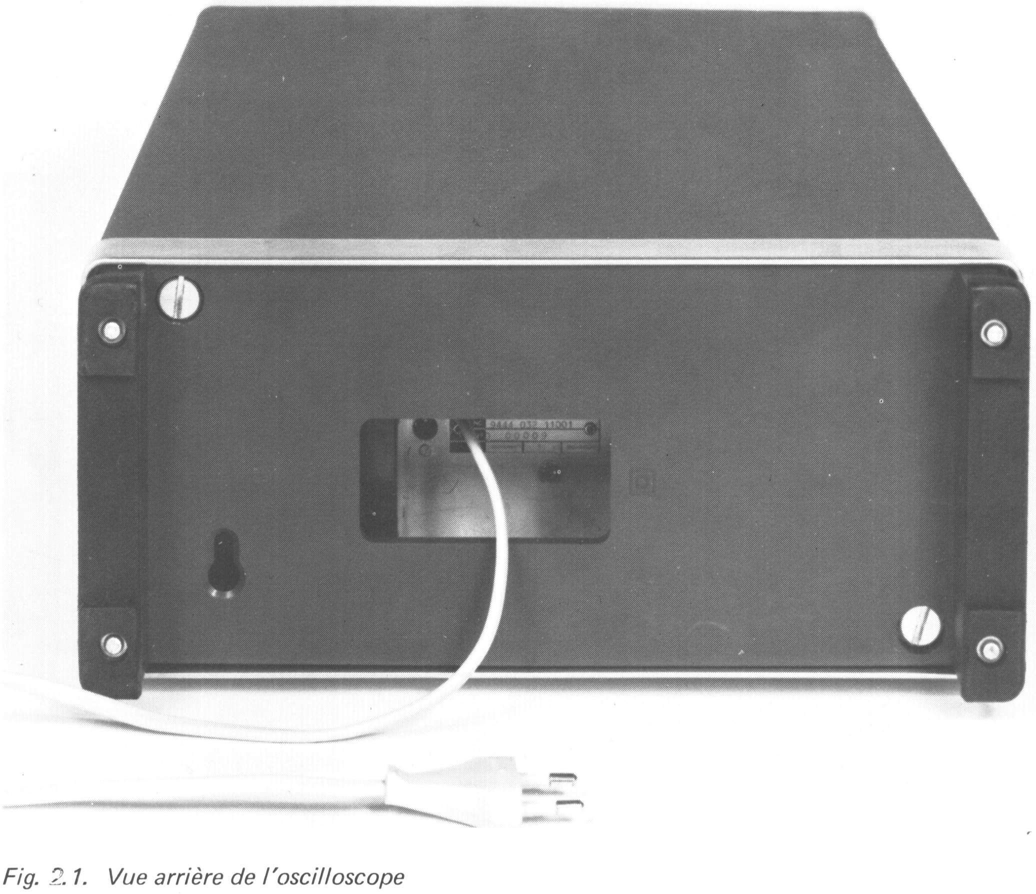


Fig. 2.1. Vue arrière de l'oscilloscope

2.1.3. Connexion à une alimentation externe 24 V en continu

L'appareil peut être équipé d'une option pour alimentation externe 24 V. L'alimentation externe ou la batterie de 23 V (± 10 %) pouvant fournir au moins 1,2 A peut être connectée à la douille à l'appareil (par ex. par le cordon secteur continu 4822 321 20125).
Le conducteur interne de la douille doit être connecté au pôle négatif et le conducteur externe au pôle positif.
Le convertisseur externe de tension continue est protégé contre les surcharges par un fusible 2 A. Ce fusible peut être remplacé après dépose de l'enveloppe de l'appareil. Pour plus de détails, voir section 3.4.

2.1.4. Couvercle avant et position de l'instrument

Pour enlever le couvercle avant, il suffit de le tirer vers soi. On peut employer l'instrument en position horizontale ou suivant plusieurs inclinaisons en se servant de la poignée de transport comme support.
Pour déverrouiller la poignée, enfoncer simultanément les deux boutons de pivotement centraux.
Voir la Fig. 2.2.: "press to unlock carrying handle".

2.2. COMMANDES ET PRISES (Voir Fig. 2.2.)

2.2.1. Tube cathodique et commandes de puissance

INTENS/POWER ON	Commande continue variable de la brillance de la trace incorporée à l'interrupteur secteur. La lampe témoin indique que l'appareil est en circuit.
FOCUS	Réglage continu de la focalisation du faisceau électronique
TRACE ROTATION	Réglage par tournevis de l'alignement du tracé sur les lignes horizontales du graticule.

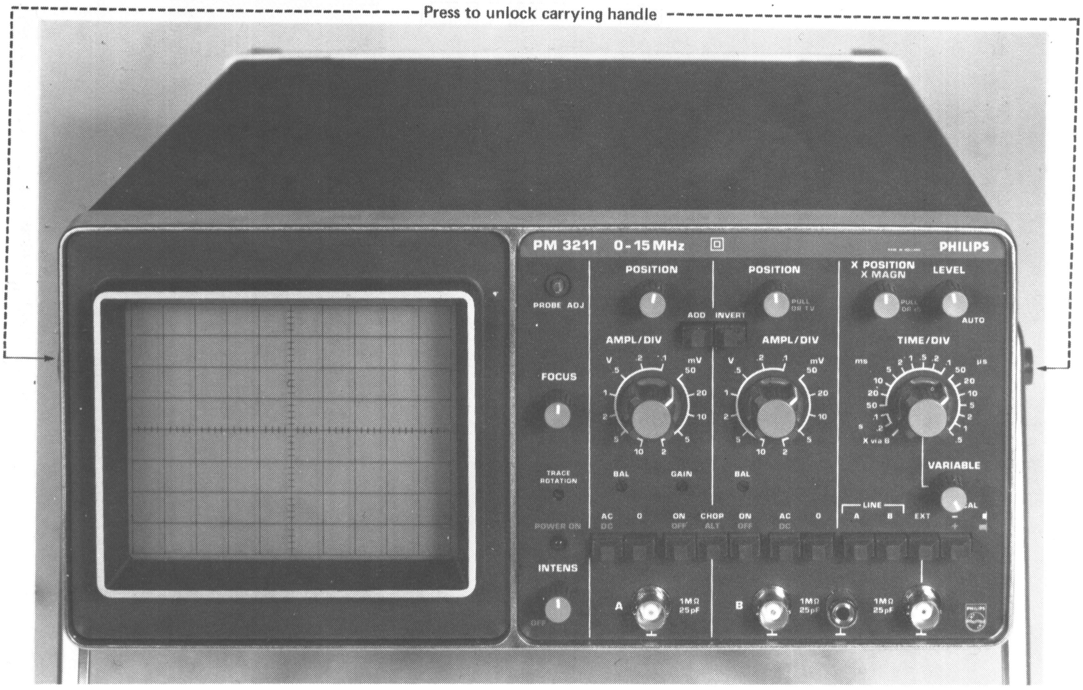


Fig. 2.2. Vue avant de l'oscilloscope montrant les commandes et douilles

2.2.2. Déviation verticale

A	Prise BNC pour entrée de la voie A
B	Prise BNC pour entrée de la voie B
AC/DC	Enfoncé: Couplage via un condensateur d'arrêt Libéré : Couplage direct
0	Enfoncé: La connexion entre le circuit d'entrée et la prise d'entrée est coupée et le circuit d'entrée est mis à la terre.
ON/OFF CH. A	Le signal d'entrée appliqué à la douille A est affiché lorsque ce bouton est enfoncé.
ON/OFF CH. B	Le signal d'entrée appliqué à la douille B est affiché lorsque ce bouton est enfoncé. Si aucun bouton n'est enfoncé, une seule voie est affichée (arbitraire).
CHOP/ALT	Si CH. A et CH. B sont en position ON, les voies peuvent être affichées en mode découpé (CHOP) ou alterné (ALT). ALT : L'affichage passe d'une voie à l'autre à la fin de chaque cycle du signal de base de temps. CHOP: L'affichage passe d'une voie à l'autre à une fréquence fixe ($f \approx 500$ kHz).
INVERT CH. B	Le signal CH. B est inversé lorsque ce bouton est enfoncé.
ADD	La déviation verticale est obtenue par la somme des voies A et B.
AMPL/DIV	Réglage échelonné des coefficients de déviation verticale, de 2 mV/DIV à 10 V/DIV dans la progression 1-2-5
POSITION	Commande de décalage vertical continu de la trace.
BAL. CH. A (CH. B)	Réglage par tournevis (panneau avant) réglé sur saut de trace minimal en commutant le bouton CH. A (CH. B) AMPL/DIV de 2 à 5 mV/DIV.
GAIN CH. A	Réglage par tournevis (panneau avant); le gain de CH. A est réglé sur une valeur égale au gain de CH. B. Ceci est nécessaire en mode A-B pour obtenir un facteur de réjection en mode commun comme spécifié (pour plus de détails, voir section 2.3.7.).

2.2.3. Base de temps

TRIGGER SOURCE A	Lorsque ce bouton est enfoncé, la base de temps peut déclencher sur un signal dérivé de la voie A.
B	Lorsque ce bouton est enfoncé, la base de temps peut déclencher sur un signal dérivé de la voie B.
LINE	Lorsque les boutons de source de déclenchement pour voies A et B sont tous deux enfoncés, la base de temps peut déclencher sur un signal dérivé de la tension secteur/réseau
EXT	Lorsque ce bouton est enfoncé, la base de temps peut déclencher sur un signal à l'entrée de déclenchement externe.
Aucun bouton enfoncé	Dans ce cas, la base de temps déclenche sur un signal dérivé de la voie A.
LEVEL	Permet le réglage du niveau de déclenchement auquel la base de temps démarre.
AUTO	En position finale de la commande LEVEL. Dans cette position, la base de temps déclenche automatiquement au niveau supérieur du signal de déclenchement. De plus, la base de temps fonctionne librement en l'absence de signal de déclenchement.

+/– SLOPE	Permet le déclenchement sur la pente positive (bouton relâché) ou négative (bouton enfoncé) du signal de déclenchement.
TIME/DIV	Sélectionne le coefficient de temps de 0,5 µs/DIV à 0,2 s/DIV en progression 1-2-5. En position X VIA B, la déviation horizontale est déterminée par le signal d'entrée voie B.
VARIABLE TIME/DIV	Commande continue variable des coefficients de temps entre les échelons TIME/DIV. Doit être en position CAL pour l'axe de temps à étalonner en fonction de l'indication du commutateur TIME/DIV.
PULL FOR TV	Le filtre TV est enclenché en position tirée du bouton POSITION voie B. La base de temps fonctionne alors en mode AUTO. Le déclenchement sur impulsions de trame (TVF) a lieu avec commutateur TIME/DIV en gamme 0,2 s ... 0,5 ms/DIV. Le déclenchement sur impulsions de ligne (TVL) avec commutateur TIME/DIV en gamme 0,2 ms ... 0,5 µs/DIV. Le bouton +/– SLOPE sert à régler l'appareil pour signaux vidéo positifs et négatifs.

2.2.4. Déviation horizontale

TIME/DIV X VIA B	Si le commutateur TIME/DIV est dans une des positions entre 0,2 s/DIV et 0,5 µs/DIV, la déviation horizontale est obtenue par le générateur de base de temps. Si le commutateur TIME/DIV est en position X VIA B, la déviation horizontale est obtenue par le signal appliqué à l'entrée de voie B. Dans ce mode, la voie B doit être mise hors service (S13 relâché) et la voie A doit être mise en service (S11 enfoncé) afin d'obtenir la seule déviation horizontale.
X POSITION PULL FOR X5	Commande de réglage continu du décalage horizontale de la trace; comporte un bouton tirette qui multiple par 5 la déviation horizontale.

2.2.5. Divers

PROBE ADJ	Prise de sortie fournissant un signal suffisant au réglage de la répond d'impulsion des sondes atténuatrices (voir 2.3.5.).
ADAPTATEUR DE TENSION SECTEUR	Le régler conformément à la section 2.1.2. avant de brancher l'instrument sur la tension secteur locale.

2.3. INSTRUCTIONS D'UTILISATION

2.3.1. Mise de l'instrument en circuit

Avant de connecter l'instrument à une source quelconque d'alimentation, il faut exécuter soigneusement les instructions de la section 2.1.

Normalement, l'oscilloscope fonctionne conformément à ses spécifications (voir section 1.2.) après une période d'échauffement d'environ 15 minutes. Toutefois, s'il à été exposé à une ambiance extrêmement froide, (par example laissé la nuit dans une voiture par temps de gel) et qu'on l'amène dans une pièce chauffée, il faut tenir compte d'une période d'échauffement suffisante (voir 1.2.8.).

2.3.2. Réglage préliminaire des commandes (POS CH. A, POS CH. B, X POS, INTENS, FOCUS)

Les opérations décrites ci-après donnent une indication générale de la correction de fonctionnement de l'oscilloscope. Elles constituent un préalable utile à l'exécution des mesures.

Voir la figure 2.2. pour la position des commandes.

Mettre les commandes INTENS et FOCUS en position médiane. Choisir le mode AUTO et un coefficient de temps moyen entre 10 ms/DIV et 10 µs/DIV avec le commutateur TIME/DIV. Enclencher CH. A et CH. B, les autres boutons-poussoirs étant en position non enfoncé. On peut positionner la trace des voies A et B sur l'écran à l'aide des commandes appropriées POSITION. Donner aux traces une brillance moyenne à l'aide de la commande INTENS et régler leur netteté à l'aide de la commande FOCUS.

2.3.3. **Couplage d'entrée** (AC/DC, 0)

Le couplage AC ou capacitif (bouton AC/DC enfoncé) permet de bloquer le composant continu d'un signal formé d'une composante alternative superposée à une composante continue.
Le choix du couplage capacitif limite les fréquences inférieures, provoquant ainsi l'atténuation des signaux sinusoïdaux à faible fréquence et la distortion des ondes carrées à faible fréquence. Le degrée d'attenuation est déterminé par le temps d'entrée RC (22 ms). Le temps d'entrée RC est multiplé par 10 si l'on emploie des sondes passives 10:1.
Lorsqu'on passe au couplage capacitif, il faut attendre environ cinq fois le temps d'entrée RC avant que la trace se stabilise à la valeur moyenne du signal d'entrée. Les mesures de position AC ne peuvent être faites par rapport à la masse.

La position 0 déconnecte la source d'entrée et court-circuite l'entrée de l'amplificateur pour le contrôle du signal zéro.

Le couplage DC ou continu (bouton AC/DC libéré) couvre toute la bande passante, c'est à dire jusqu'au courant continu.

2.3.4. **Emploi des sondes**

Les sondes passives 1:1 ne doivent être employées que pour le courant continu et les basse fréquences.
La charge capacitive atténue les hautes fréquences ou augmente le temps de montée des signaux de mesure (en fonction de l'impédance de source).

Les sondes passives 10:1 ont une charge capacitive moins grande, généralement environ 10 pF à 20 pF. Les sondes FET sont supérieures, en particulier si les mesures doivent être prises en des points à impédance élevée ou à la limite supérieure de la bande de fréquence de l'oscilloscope.

Les sondes passives 10:1 doivent être compensées correctement avant emploi. Une compensation incorrecte provoque la distortion des impulsions ou des erreurs d'amplitude aux fréquences élevées.
Pour un réglage correct, on peut utiliser la prise de sortie PROBE ADJ. (voir Fig. 2.3.).

2.3.5. **Réglage des sondes atténuatrices PM 8925, PM 8925L et PM 8932** (PROBE ADJ)

- Représenter une ligne de base de temps en sélectionnant le mode LINE (enfoncer les boutons-poussoirs A et B simultanément).
- Tourner le potentiomètre LEVEL complètement vers la droite (position AUTO).
- Relâcher le bouton-poussoir AC/DC (S9); choisir le mode DC.
- Mettre le commutateur AMPL/DIV (S5) sur 5 mV/DIV.
- Connecter la boîte de compensation à la douille A (X2) et placer l'extrémité de sonde sur la borne PROBE ADJ.
- Choisir 0,5 ms/DIV ou 0,2 ms/DIV.
- Introduire un petit tournevis dans l'ouverture de la boîte de compensation; régler ainsi le trimmer afin d'obtenir une représentation correcte comme illustrée correcte à la Fig. 2.3.

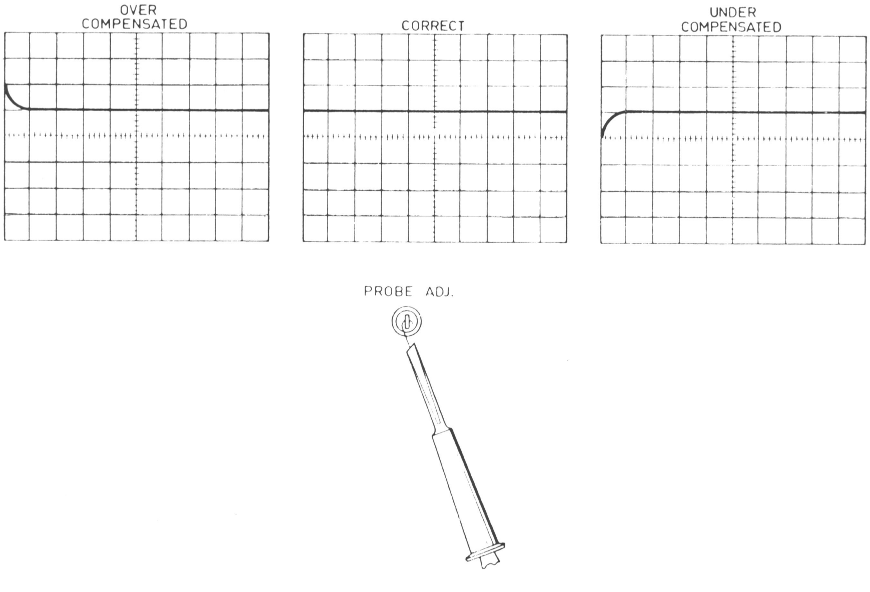


Fig. 2.3. Réglage des sondes atténuatrices PM 8925, PM 8925L et PM 8932

2.3.6. **Choix entre modes découpé et alterné** (CH. A ON, CH. B ON, CHOP/ALT, ADD)

En fonctionnement à double trace il faut choisir le mode découpé (CHOP/ALT enfoncé) pour des vitesses de balayage relativement faibles (0,2 s/DIV ... 0,1 ms/DIV) ou pour des faibles fréquences de répétition du balayage, même s'il est rapide. Le choix du mode alterné (ALT) dans ces conditions rendrait difficile la comparaison des formes d'ondes, parce que les traces apparaîtraient en fait **successivement**. Toutefois, si l'affichage est assez rapide pour être interrompu par la fréquence de commutation, il faut choisir le mode alterné (bouton AC/DC relâché), généralement pour des vitesses de balayage supérieures à 0,1 ms/DIV.

2.3.7. **Mode différentiel** (ADD, CH. B INVERT, CH. A GAIN)

On peut choisir le mode A-B en enfonçant les boutons ADD et INVERT.

Dans les mesures au cours desquelles il y a réception de signaux de mode commun de valeur appréciable (par exemple ronflement), le mode différentiel annule ces signaux pour ne conserver que la valeur intéressante (A-B). L'amplitude de l'oscilloscope à supprimer les signaux de mode commun est donnée par le coefficient de réjection mode commun (CMR) (voir Fig. 2.4.).

Pour obtenir le degré spécifié de réjection mode commun, il faut tout d'abord égaliser les gains respectifs des voies A et B. On peut obtenir ce résultat en connectant les deux voies au même signal et en ajustant CH. A GAIN (réglage tourne vis, panneau avant) sur déviation minimale.

Si l'on emploie des sondes passives 10:1, il est recommandé d'employer une methode d'égalisation similaire consistant à régler leurs commandes de compensation pour une déviation minimale.

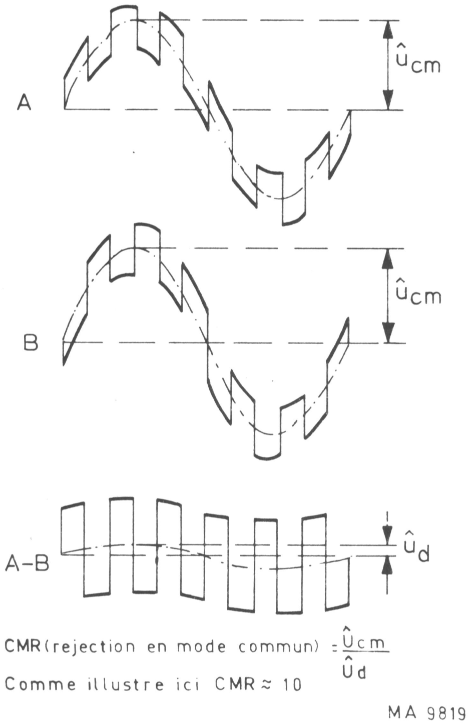

A
û cm
B
û cm
A–B
û d
CMR (rejection en mode commun) = Û cm / Û d
Comme illustre ici CMR ≈ 10
MA 9819

Fig. 2.4. Réjection en mode commun

2.3.8. **Sélection de source de déclenchement** (A, B, LINE, EXT)

Le sélecteur de source de déclenchement permet de sélectionner le signal sur lequel la base de temps peut déclencher. Les sources de déclencher peuvent être:

- **A ou B:** le déclenchement a lieu sur le signal dérivé du signal d'entrée vertical voie A ou B.
  Pour comparer les formes d'ondes dont les fréquences sont des multiples les une des autres, toujours choisir comme source de déclenchement le signal qui à la fréquence de répétition la plus faible.
  Sinon on risque d'obtenir des images doubles (mode commuté) ou des décalages de temps incorrects (mode alterné).

- **LINE:** le déclenchement réseau/secteur est utile lorsque le signal à mesurer se rapporte à la fréquence secteur.
- **EXT:** Si l'on affichage de nombreux signaux, il est de se servir du signal externe pour le déclenchement Il n'est pas nécessaire de régler à nouveau les commandes de déclenchement (LEVEL, SLOPE et SOURCE) à chaque changement de signal d'entrée. De plus, les deux entrées A et B restent libres pour l'examen des formes d'onde.
- Si aucun bouton n'est enfoncé, la base de temps déclenchera au signal dérivé de la voie A.

Le sélecteur de déclenchement est couplé en alternatif. Etant donné le niveau auquel l'affichage démarre, on obtient des changements de la valeur moyenne du signal de déclenchement. De ce fait, le niveau de déclenchement ne peut pas être référé à la terre de signal. Ceci peut causer l'instabilité des ondes, variant ainsi l'intervalle de temps de cycle en cycle. Si le niveau d'instabilité est inacceptable, il faut passer en mode AUTO afin d'obtenir un déclenchement de niveau au sommet.

2.3.9. **Sélection du mode de déclenchement** (AUTO, LEVEL, SLOPE)

Le mode AUTO (commande LEVEL en position extrême droite) est d'une grande utilisé, car il fournit des traces à l'écran même en l'absence de signaux de déclenchement; en effet, la base de temps devient libre 100 ms après le dernier signal de déclenchement.
En mode AUTO le déclenchement a lieu au sommet du signal de déclenchement.

Le mode AUTO ne peut être utilisé pour des signaux à taux de répetition de 20 Hz ou moins, car dans ce cas la base de temps peut devenir libre. Dans tel cas, la mode de déclenchement normal doit être utilisé: la commande LEVEL n'est plus en position AUTO et doit être réglée en position appropriée.

Le bouton +/– SLOPE sélectionne la base de temps à déclencher sur la pente positive ou négative du signal de déclenchement.

2.3.10. **Mode X VIA B** (TIME/DIV)

Les mesures X VIA B s'effectuent à l'aide du commutateur TIME/DIV en position X VIA B.
Ces mesures sont très utiles à la comparaison de fréquences ou de déphasages dans les figures de Lissajous.
Elles peuvent se faire jusqu'à 50 kHz avec erreur de phase inférieure à 3° entre la voie horizontale et la voie verticale.
La sensibilité X = AMPL/DIV CH. B ± 15 %.

2.4. DEPOSE DES FUSIBLES, DE LA VISIERE, DE LA PLAQUE DE CONTRASTE ET DU GRATICULE

2.4.1. Dépose des couvercles

D'abord s'assurer que l'appareil est débranché de toute tension.
Procéder comme suit:

- Pivoter la poignée de telle sorte que l'appareil puisse être placer avec le couvercle frontal sur une surface plane.
- Desserrer les vis centre de la plaque arrière.
- Enlever la plaque arrière.
- Soulever l'enveloppe.
- Pour accéder au panneau avant, mettre l'appareil en position horizontale et déboîter le couvercle.

2.4.2. Remplacement du fusible thermique F802

- Enlever les couvercles d'appareil comme décrit à la section 2.4.1.
- Enlever le couvercle plastique.
  Ce couvercle présente 4 pinces qui s'adaptent dans les trous rectangulaires de la plaque métallique arrière. Pour la dépose recourber légèrement les côtés par pression aux points d'attache et enlever le couvercle de la plaque arrière.
- Dépose de l'élément du fusible (voir Fig. 2.5.).
  Dessouder et détacher les fils secteur du côté fusible du transformateur. Dessouder les bornes de fusible. Recourber légèrement le boîtier vers l'extérieur (en utilisant un petit tournevis) de sorte que la goupille d'arrêt soit dégagé. On peut alors facilement extraire le fusible de son boîtier.
- Montage d'un nouvel élément de fusible:
  Procéder comme décrit ci-avant.

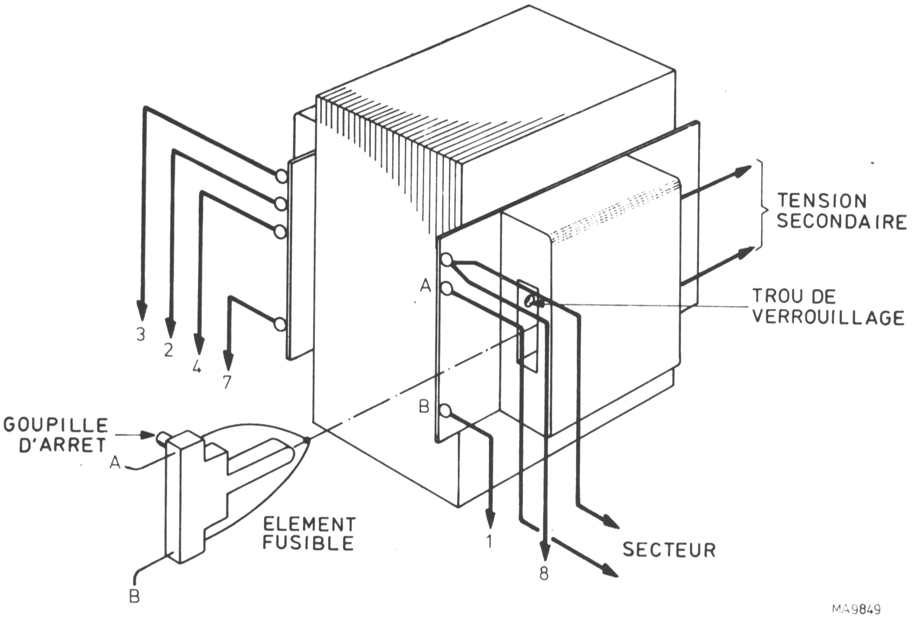


Fig. 2.5. Transformateur secteur et position du fusible thermique.
Les chiffres correspondent aux connections de l'adaptateur de tension secteur.

Glisser le nouvel élément dans le boîtier jusqu'à ce que la goupille s'adapte dans le trou avec un déclic. Ensuite, souder les deux fils de fusible et les fils secteur.

2.4.3. Remplacement du fusible F801

- Déposer les couvercles d'appareil comme décrit à la section 2.4.1.
- Le fusible F801 (500 mA, rapide) sur la platine d'alimentation peut alors facilement être déposée.

2.4.4. Dépose de la visière et de la plaque de contraste

- Prendre la visière aux coins inférieurs et l'extraire doucement du panneau avant (voir Fig. 2.6.).
- La plaque de contraste peut être déposée en l'extrayant de la visière par légère pression.

2.4.5. Dépose de la plaque de graticule

- Détacher le graticule du tube avec un petit tournevis ou avec l'ongle.
- Lorsque cet espace est accrû, le côté gauche du graticule peut être déboîté du profilé avant.
- Ensuite, la plaque de graticule peut être déposée.
- Pour le remontage placer d'abordle côté droit.

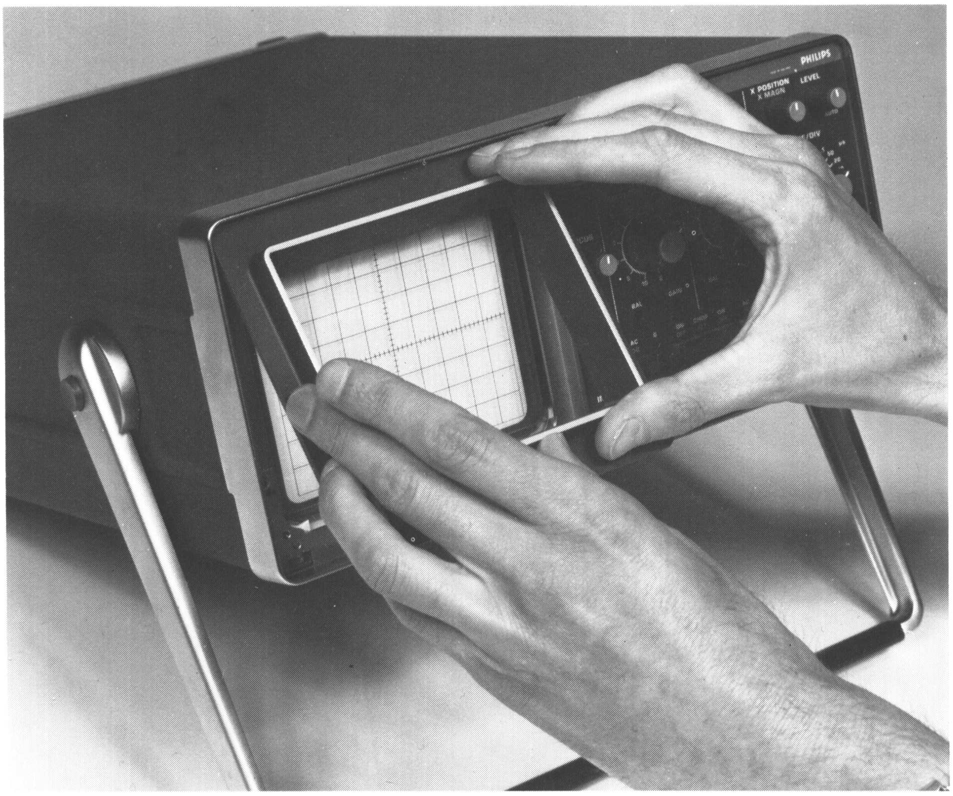


Fig. 2.6. Dépose de la visière et de plaque de contraste

Service data

3. Service data

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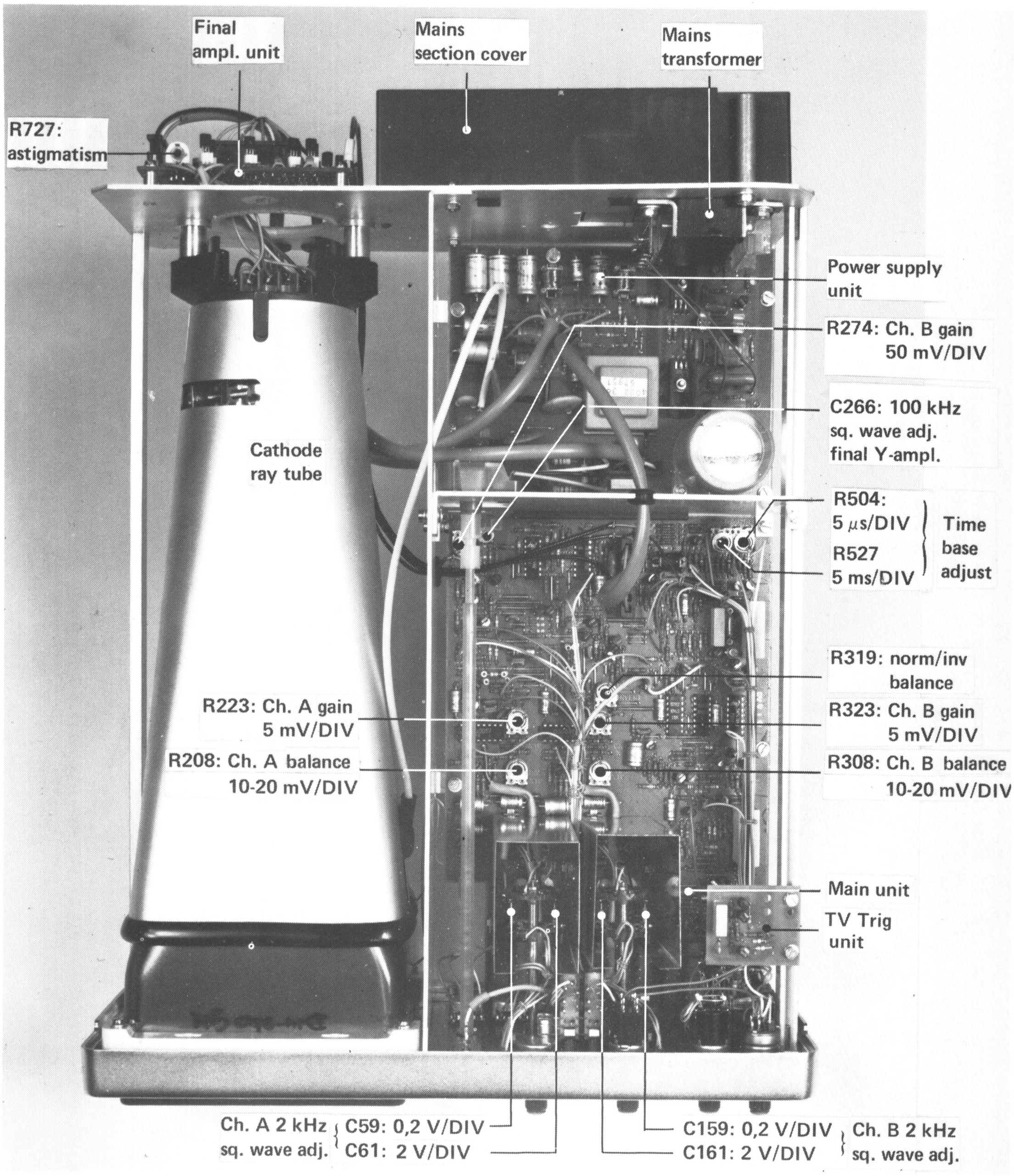


Fig. 3.1. Unit location and adjustment points, top view

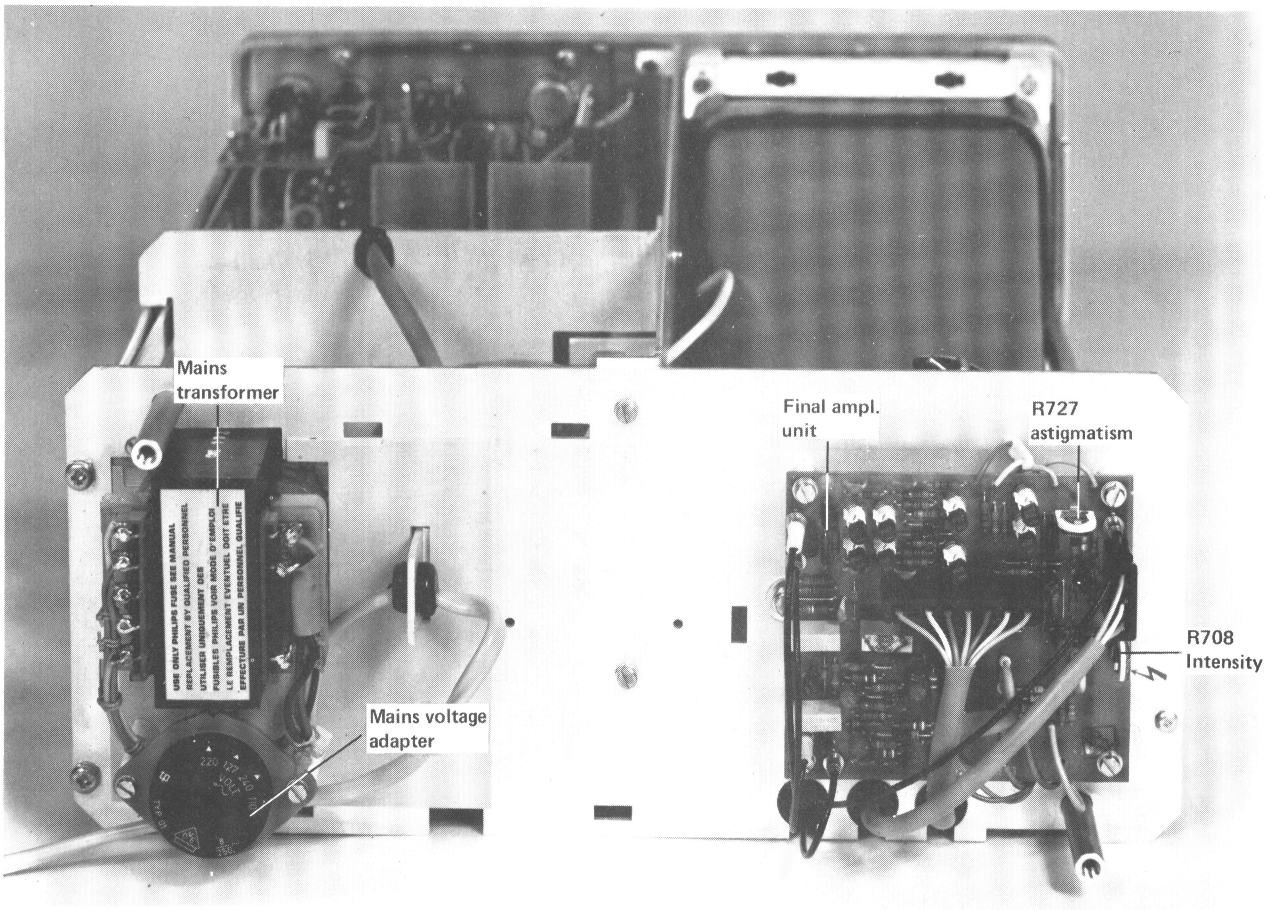


Fig. 3.2. Unit location and adjustment points, rear view

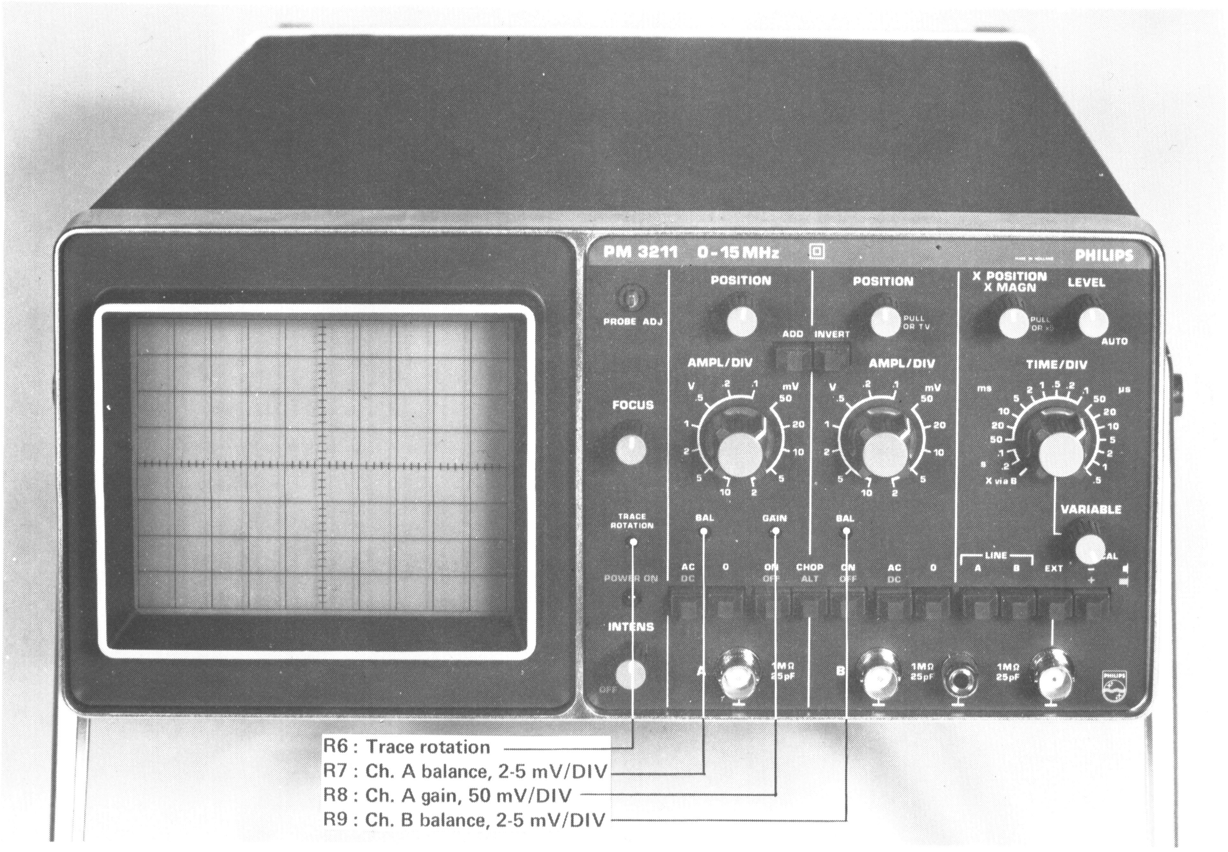

PM 3211 0-15 MHz
PHILIPS
R6 : Trace rotation
R7 : Ch. A balance, 2-5 mV/DIV
R8 : Ch. A gain, 50 mV/DIV
R9 : Ch. B balance, 2-5 mV/DIV

Fig. 3.3. Adjustment points, front view.

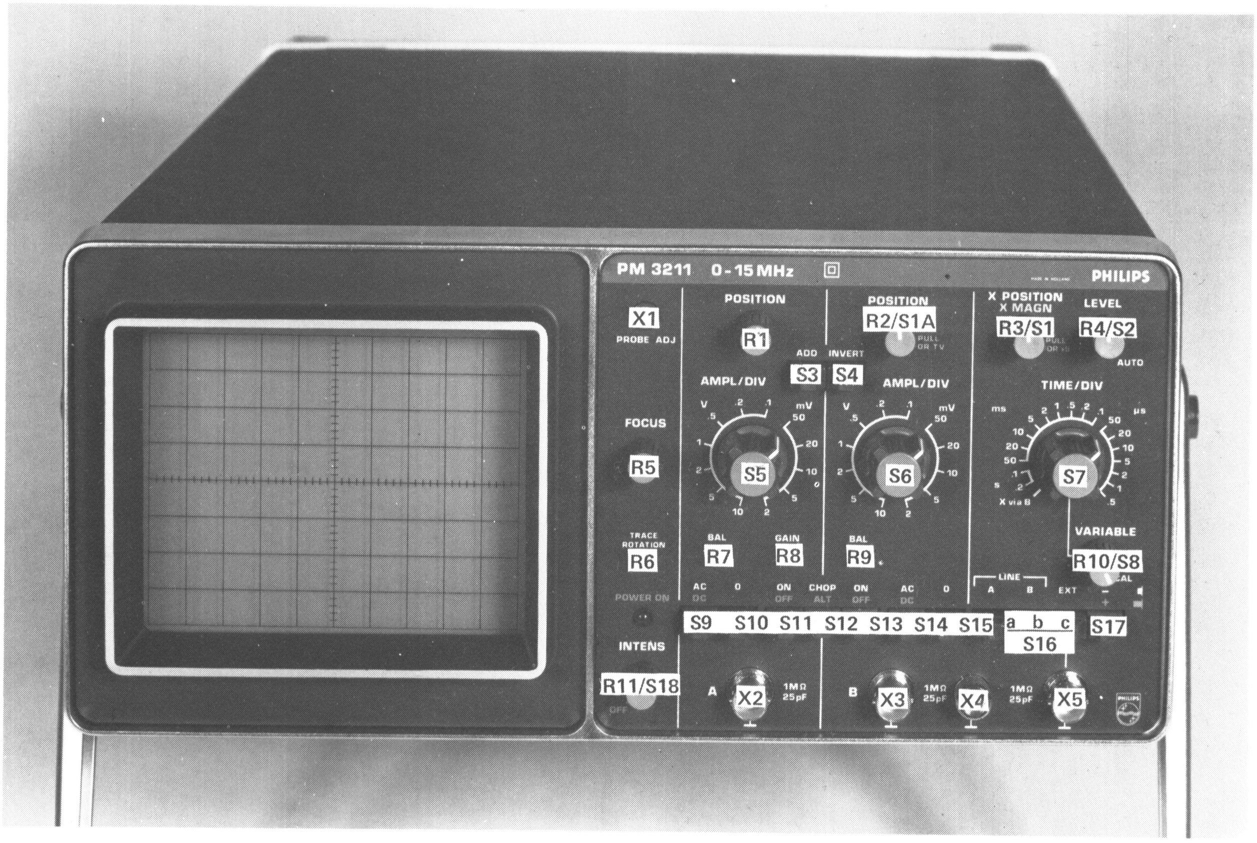


Fig. 3.4. Electrical item numbers, front panel

3. Service Data

3.1. DISMANTLING THE INSTRUMENT

3.1.1. Precautions

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations.
During dismantling procedures a careful note of all leads disconnected must be made to ensure correct reconnection to the appropriate terminals during assembly.

Always ensure that the mains supply is disconnected before removing any of the instrument cover plates. Damage may result if the instrument is switched on when a circuit-board has been removed, or if a circuit-board is removed within one minute of switching off the instrument.

3.1.2. Removing the screen bezel and the contrast plate

- Grip the bottom corners of the bezel and gently pull it from the front panel (see Fig. 3.5.).
- The contrast filter can be removed by pressing it gently out of the bezel.

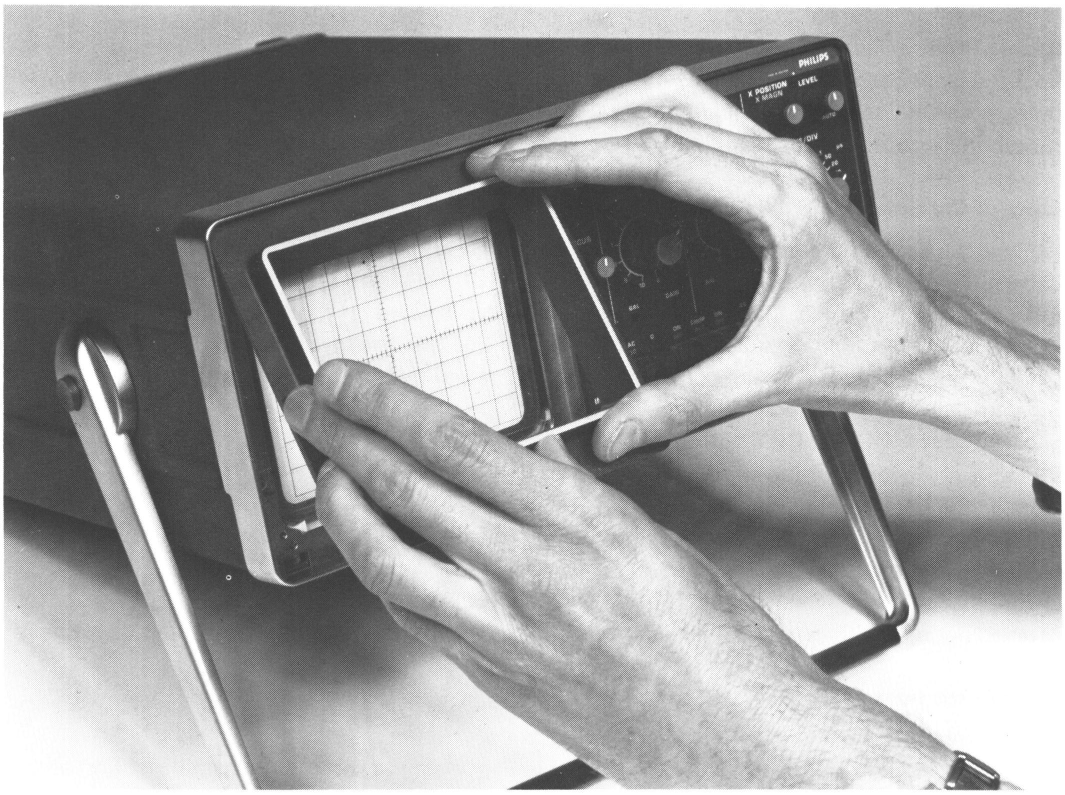


Fig. 3.5. Removing the screen bezel and the contrast plate

3.1.3. Removing the graticule plate

- Gently ease the graticule plate from the CRT screen using your fingernails or a small screwdriver.
- Increase this space until it is possible to release the left-hand side of the graticule plate from the front profile.
- After releasing this side the graticule plate can be removed.
  To refit the graticule plate; first install the right-hand side and then the left-hand side.

3.1.4. Removing the instrument covers

Before removing the instrument covers disconnect the instrument from the mains voltage.
Proceed as follows:

- Put the carrying handle insuch a position that the instrument can stand on its protective front cover on a flat surface.
- Unscrew the two coin-slot screws on the rear panel.
- Lift the rear panel.
- Lift off the wrap-around cover.
- For access to the front panel, stand the instrument horizontally and snap off the cover.

3.1.5. Removing the carrying handle

- Prise off the centre knobs from each pivot, using a small screwdriver in one of the small slots at the sides of the knobs.
- Remove the cross-slotted screws and washers that are now accessible.
- Flex both arms of the handle slightly outwards and take it off the wrap-around cover.
- The plastic bearing bushes which are visible now, contain, in sequence of dismantling, a metal ratchet and a spring.
- Grip and arms of the carrying handle must be ordered separately (see list of mechanical parts).
  A complete carrying handle can easily be constructed by pressing the arms into the grip.

3.1.6. Removal of the final amplifier unit

- Unplug five coaxial plugs, a three-pole and a seven-pole plug.
- Note the leads connecting this unit to the CRT socket and a four-pole plug or the power supply unit.
  Unplug the CRT socket carefully, and also the four-pole plug on the power supply.
- Loosen the four screws attaching the unit to the rear chassis plate and the unit can be removed.

3.1.7. Removal of the cathode ray tube (CRT)

- Remove the screen bezel and graticule plate as explained in section 3.1.2. and 3.1.3.
- Loosen the plastic clamping supports on the top and bottom screen side of the CRT so that the screen is still supported, but can easily be taken out of the supports when removing it.
  Every support it mounted to the front panel by means of two screws.
- Unsolder the two trace-rotation coil leads from the bottom side of the main unit.
- Remove the CRT socket carefully.
- Loosen the screw in the CRT bottom clamping spring.
- Disconnect the high-tension side connection from the CRT.
- Remove the CRT from the instrument.
- When mounting the CRT, handle in reversed sequence and take special care when screwing down the CRT clamping spring.
  Ensure that the CRT screen is a close fit to the graticule plate.
  After soldering the trace-rotation leads check that the rotation functions in the proper direction.

3.1.8. Removal of the power supply unit

- Unplug the four-pole and the three-pole plugs on the unit.
- Unplug the six-pole plug on the main unit and the seven-pole plug on the final amplifier unit and loosen the rubber clamps with which the two cables are attached to the chassis.
- Unsolder the two leads at the mains transformer, the high-tension cable, and the two leads from the mains switch at the bottom side of the unit.
- Loosen the four screws attaching the unit to the chassis.
- Lift the unit slightly at the mains transformer side and slide it sideways out of the plastic mounting strip and out of the chassis. The mounting strip also supports the main unit.

3.1.9. Removal of the mains transformer

- Unsolder the primary and secondary leads on the transformer. For mounting refer to Fig. 2.5. in the chapter "Replacing the thermal fuse" (chapter 2.4.2.).
- Loosen the four mounting screws and slide the transformer in the direction of the front panel out from the rear chassis plate.

3.1.10. Removal of the main unit

- Remove the attenuator screens. When remounting take care to locate them in the correct positions.
- Disconnect the calibration voltage lead from the terminal and unsolder the wires of the trace-rotation coil from the under-side of the printed-circuit board.
- Loosen two screws at the top of the control panel, the earth terminal at the bottom and the five screws attaching the printed-circuit board to the chassis.
  When mounting the unit in the instrument, first insert all screws loosely, and then tighten when all screws are in place.
- Disconnect five coaxial leads from their sockets on the final amplifier unit.
- Remove the INTENSITY and FOCUS knob.
- Pull the unit about 5 cm forward and feed the coaxial leads from the final amplifier unit through two rubber clamps.
  When remounting the unit ensure that the unit fits in its final position in the plastic mounting strip and under a mounting section of the plate between the power unit and main unit.
- Unsolder the leads from TRACE ROTATION potentiometer and POWER ON LED.
- Slide and till the unit out of the instrument.

3.1.11. Removal of the knobs and textplate

- Removal of the knobs:

  Attenuator and time-base switches: take the shields out of the knobs and loosen the exposed nuts with a pair of pliers.
  Horizontal position and magnifier: remove the shield and loosen screw inside knob.
  Other knobs: these have a clamping spring inside that can be levered off the spindle.

- Removal of the textplate:

  Remove the nuts from the attenuator and time-base switches and take off the textplate.

3.1.12. Replacing a switch of a pushbutton unit (Fig. 3.6.)

- Straighten the four retaining lugs of the relevant switch.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces.
  The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (for instance, with a sucking-iron).
- Solder the new switch on to the printed-wiring board.
- Bend the four retaining lugs back to their original positions.
- If the faulty pushbutton unit cannot be reached remove the main unit as described in section 3.1.10. and eventually the control panel.

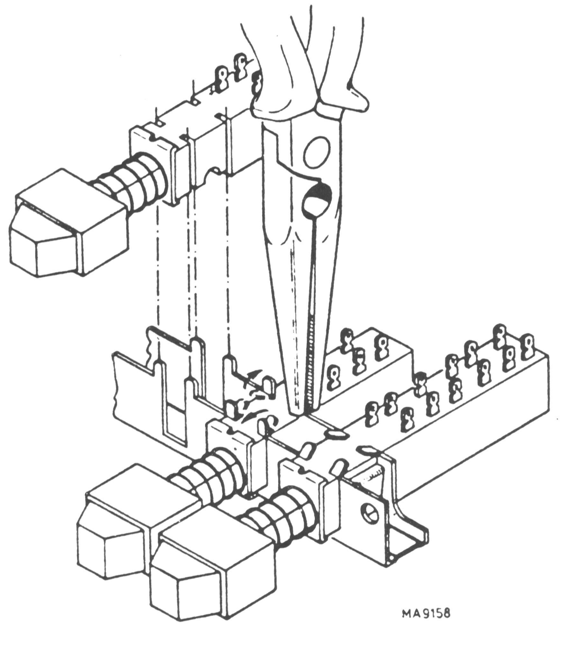


Fig. 3.6. Replacing a push-button switch

3.2. CHECKING AND ADJUSTING

3.2.1. Introduction

3.2.1.1. *Measuring equipment and settings of oscilloscope under test*

For checking and adjusting a signal generator is necessary that can produce at least the following voltages and frequencies:

- sinewaves with an amplitude between 30 mV and 1.4 V p-p (peak-peak) and a frequency between 10 Hz and 15 MHz.
- squarewaves with an amplitude of 1,2 V and 12 V and a frequency of 2 kHz.
- a squarewave with an amplitude of 60 mV a repetition rate of 100 kHz and a risetime of at least 3 ns.

The adjustment points with their function and location are indicated in Figs. 3.1., 3.2. and 3.3.

In the following adjustment procedure the controls have the positions as listed unless otherwise stated:

- CH. A and CH. B AC/DC buttons (S9 and S14) released.
- CH. A and CH. B 0-buttons (S10 and S15) released.
- CH. A and CH. B ON/OFF buttons (S11 and S13) released.
- ADD and CH. B INVERT buttons (S3 and S4) released.
- LEVEL control (R4 and S2) in the AUTO position.
- VARIABLE TIME/DIV control (R10 and S8) in the CAL position.
- X MAGN control (S1) must be depressed (X1 position).
- The +/– SLOPE button (S17) must be released (+ SLOPE position).
- FOCUS (R5), INTENS (R11), CH. A POSITION (R1), CH. B POSITION (R2), X POSITION (R3) adjusted to obtain a good display.

The adjustment points are located on the main unit unless otherwise stated in this procedure.

3.2.1.2. *Trimming Tool Kit (Type 800/NTX)*

This useful kit contains 3 twin-coloured holders, 2 extension holders and 21 interchangeable trimming pins. The wide variety of pins allows almost every type of trimming function to be carried out in instruments to be calibrated (e.g. measuring instruments, radio and T.V. sets).

Ordering number: 4822 310 50015.
(A spare set containing the 8 most commonly used pins is available under the Ordering number: 4822 310 50016).

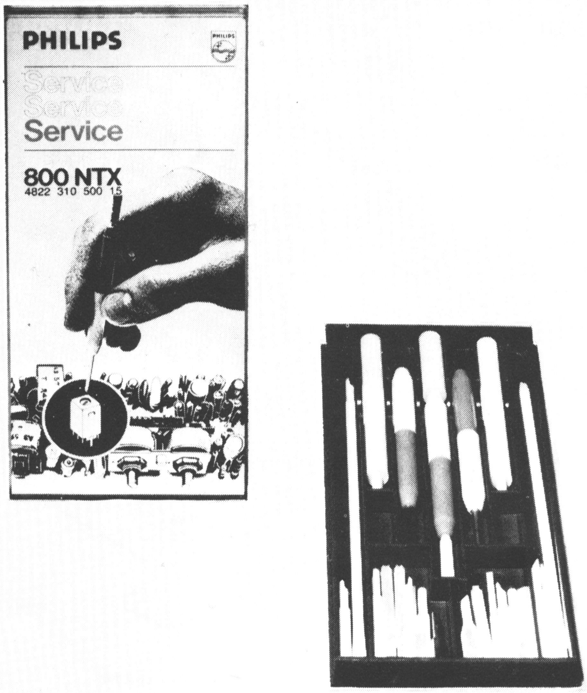


Fig. 3.7. Trimming tool kit 800 NTX

3.2.2. C.R.T. display section

3.2.2.1. INTENSITY, adjustment (R708):

- TIME/DIV switch (S7) in position X VIA B
- CH. B ON/OFF button (S13) in ON position.
- FOCUS control (R5) in the mid-position.
- Turn the INTENS control (R11) approx. 90 degrees clockwise from the mains ON/OFF point.
- Adjust the CH. B. POSITION (R2) and X POSITION (R3) controls so that the spot is in the middle of the graticule.
- Adjust preset potentiometer R708 so that the spot is just visible. R708 is marked VG1 and located on the final amplifier unit.

3.2.2.2. FOCUS and ASTIGMATISM adjustment (R5 and R727):

- TIME/DIV switch (S7) in position 50 μs/DIV
- Depress the CH. B ON/OFF button (S13)
- Depress button B (S16b) on the trigger source selector.
- Apply a sinewave of approx 10 kHz to the CH. B input (X3). This signal must give a deflection of approximately 6 divisions.
- Adjust R727 (AST). and R5 (FOCUS) in order to obtain sharp lines over the whole screen.
  R5 must be near to the mid-position after adjustment.
  R727 is located on the final amplifier unit.

3.2.2.3. TRACE ROTATION adjustment (R6):

- Depress the CH. B ON/OFF button (S13)
- TIME/DIV switch (S7) on 0,1 ms/DIV
- CH. B POSITION (R2) in middle of graticule
- Adjust the TRACE ROTATION control (R6) so that the time-base line is in parallel with the graticule.
  R6 is a front panel screw driver adjustment point.

3.2.3. Vertical deflection

The CH. A and CH. B amplifiers are nearly identical. For adjustment procedures that are identical for CH. A and CH. B the controls and adjustment points are noted as follows:
for instance the POSITION controls for CH. A/CH. B are (R1/R2).

3.2.3.1. DC BALANCE X1 adjustment CH.A/CH. B (R7/R9)

- Depress the CH. A/CH. B ON/OFF button (S11/S13).
- Depress the CH. A/CH. B O-button (S10/S15).
- Adjust the frontpanel BAL (X1) adjustment point (R7/R9) to minimum time-base line jump when switching the CH. A/CH. B AMPL/DIV switch (S5/S6) between 2 and 5 mV/DIV.
  Max. allowed time-base line jump 0,3 DIV.

3.2.3.2. DC BALANCE X10 adjustment CH. A/CH. B (R208/R308)

- Depress the CH. A/CH. B ON/OFF button (S11/S13).
- Depress the CH. A/CH. B 0-button (S10/S15).
- Adjust preset potentiometer (R208/R308 marked BAL X10) to minimum time-base line jump when switching the CH. A/CH. B AMPL/DIV switch (S5/S6) between 10 and 20 mV/DIV.
  Maximum allowed time-base line jump 0,3 DIV.

3.2.3.3. NORMAL/INVERT BALANCE CH. B adjustment (R319)

- Depress the CH. B ON/OFF button (S13)
- Adjust R319 (marked BAL INVERT) to minimum time-base line jump when operating the NORMAL/INVERT button (S4),
  Max. allowed time-base line jump 0,3 DIV.

3.2.3.4. *GAIN X1 adjustment CH. B (R274)*

- AMPL/DIV switch (S6) in 50 mV/DIV position
- TIME/DIV switch (S7) in 0,2 ms/DIV position
- Depress the CH. B ON/OFF button (S13).
- Depress button B (S16.b) on the trigger source selector.
- Apply to the CH. B input (X3) a calibrated signal of 300 mV and a frequency of approx. 2 kHz and adjust R274 (marked GAIN CH. B) to 6 divisions deflection on the screen.

3.2.3.5. *GAIN X10 adjustment CH. B (R323)*

- AMPL/DIV switch (S6) in 5 mV/DIV position.
- Other control positions as indicated in part. 3.2.3.4.
- Apply to the CH. B input (X3) a calibrated signal of 30 mV and a frequency of approx. 2 kHz and adjust R323 (marked GAIN X10) to 6 divisions deflection on the screen.

3.2.3.6. *GAIN X1 adjustment CH. A (R8)*

- AMPL/DIV switch (S5) in 50 mV/DIV position.
- Depress the CH. A ON/OFF button (S11).
- Depress button A (S16a) on the trigger source selector.
- Apply to the CH. A input (X2) a calibrated signal of 300 mV and a frequency of approx. 2 kHz and adjust front panel adjustment point R8 (marked GAIN) to 6 divisions on the screen.

3.2.3.7. *GAIN X10 ADJUSTMENT CH. A. (R223)*

- AMPL/DIV switch (S5) in 5 mV/DIV position
- Other control positions as indicated under point 6.
- Apply to the CH. A input (X2) a calibrated signal of 30 mV and a frequency of approx. 2 kHz and adjust R223 (marked GAIN X10) to 6 divisions deflection on the screen.

3.2.3.8. *SQUARE WAVE ADJUSTMENT INPUT ATTENUATOR CH. A/CH. B (C59, C61/C159, C161)*

- TIME/DIV switch (S7) in 0,2 ms/DIV position.
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Depress button A/B on the trigger source selector (S16a/S16b)
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 0,2 V/DIV position and apply to the CH. A/CH. B input a 2 kHz squarewave signal of 1,2 V.
- Adjust C59/C159 for optimum squarewave response, without having removed the attenuator shield plates.
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 2 V/DIV position and apply to the CH. A/CH. B input a 2 kHz square-wave signal of 12 V.
- Adjust C61/C161 for optimum squarewave response, without having removed the attenuator shield plates.

3.2.3.9. *SQUARE WAVE RESPONSE FINAL Y AMPLIFIER (C266)*

- Put the TIME/DIV switch (S7) in position 2 μs/DIV
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Depress button A/B on the trigger source selector (S16a/S16b)
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 10 mV/DIV position
- Apply to the CH. A/CH. B input (X2/X3) a square-wave signals of 60 mV p-p a risetime $\leqslant 3$ ns and a repetition rate of approx. 100 kHz.
- Adjust C266 for optimum square-wave response: maximal *pulse droop* 0,2 DIV
  maximal pulse aberration 0,2 DIV

3.2.3.10. *CHECKING THE BANDWIDTH OF CH. A/CH. B*

- Put the TIME/DIV switch (S7) in the 0,1 ms/DIV position.
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Depress the A/B button on the trigger source selector (S16a/S16b)
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6 in the 10 mV/DIV position.

- Apply to the CH, A/CH. B input (X2/X3) a sinewave of 60 mV p-p and a frequency of approx. 100 kHz The vertical deflection now is 6 DIV
- Increase the frequency to 15 MHz and keep the amplitude to 60 mV p-p. Check that the vertical deflection on the screen is 4,2 DIV or more.
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 20 mV/DIV position
- Increase the voltage on the CH. A/CH. B input (X2/X3) to 120 mV p-p. Check that the vertical deflection on the screen is 4,2 DIV or more.

3.2.3.11. HIGH FREQUENCY DYNAMIC RANGE AND SHIFT RANGE CH. A/CH. B

- Put the TIME/DIV switch (S7) in the 0,2 μs/DIV position
- Put the CH. A/CH. B AMPL/DIV switch (S5/S6) in the 5 mV/DIV position
- Depress the CH. A/CH. B ON/OFF button (S11/S13)
- Release the CH. B/CH. A ON/OFF button (S13/S11)
- Apply to the CH. A/CH. B input (X2/X3) a sinewave signal of 120 mV p-p and a frequency of 5 MHz
- Check if it is possible to shift the top and bottom of the trace within the graticule by the use of the CH. A/CH. B POSITION control (R1/R2).

3.2.3.12. COMMON MODE REJECTION ADJUSTMENT (R8)

- Depress the ADD-button (S3)
- Depress the INVERT -button (S4)
- Put the CH. A and CH. B AMPL/DIV switches (S5 and S6) in the 10 mV/DIV position.
- Apply to the CH. A and CH. B inputs (X2 and X3) the same sinewave signal of 120 mV p-p and 1 MHz
- The common-mode rejection (CMR) must be better than 100 times; the amplitude on the screen must be smaller than 0,12 DIV.
  If not, readjust the front-panel adjustment point CH. A GAIN (R8)

3.2.3.13. CHOPPED AND ALTERNATE MODE check

- Put the TIME/DIV switch (S7) in the 20 ms/DIV position
- Depress the CH. A and CH. B 0-buttons (S10 and S15)
- Depress the CH. A and CH. B ON/OFF buttons (S11 and S13)
- Release the CHOP/ALT button (S12)
- Check that two lines are written on the screen one by one.
- Depress the CHOP/ALT button (S12)
- Check that two lines are written on the screen simultaneous.
- Put the TIME/DIV switch in the 20 μs/DIV position.
- Turn the INTENS control (R11) fully clockwise
- Check that the two lines on the screen are sharp and well-defined.

3.2.3.14. CROSS-TALK check CH. A to CH. B/CH. B to CH. A

- Release the CHOP/ALT button S12
- Put the CH. A and CH. B AMPL/DIV switches (S5 and S6) in the 20 mV/DIV position
- Put the TIME/DIV switch in the 0,5 μs/DIV position
- Depress the CH. B/CH. A 0-button (S15/S10)
- Depress the CH. A and CH. B ON/OFF button (S11 and S13)
- Apply a 10 MHz sinewave of 8 divisions to the CH. A/CH. B input (X2/X3)
- Check that the CH. B/CH. A trace shows a signal with an amplitude of 0,08 divisions or less.

3.2.4. Time-base and horizontal deflection

3.2.4.1. TRIGGER SLOPE CHECK

- Put the TIME/DIV switch (S7) in the 0,2 ms/DIV position
- Put the CH. B AMPL/DIV switch (S6) in the 0.1 V/DIV position
- Depress the CH. B ON/OFF button (S13)
- Depress the B button on the trigger source selector (S16b).
- Apply to the CH. B input (X3) a sinewave voltage of 600 mV and a frequency of approx. 2 kHz.
- Adjust the LEVEL control (R4) so that the sinewave starts at about the 0 volt level.
- Depress the +/— SLOPE button (S17) and check that the trace starts on the negative-going slope of the signal.

- Release the +/– SLOPE button (S17) and check that the trace starts on the positive-going slope of the signal.
- Check that turning the LEVEL control (R4) clockwise results in an upward shift of the starting point of the trace.

3.2.4.2. *INTERNAL LEVEL RANGE check*

- Switch positions as descibed above.
- Apply to the CH. B input (X3) a sinewave voltage of 480 mV and a frequency of approx. 2 kHz.
- Change the position of the CH. B AMPL/DIV switch to 20 mV/DIV in order to obtain a vertical deflection of 24 divisions.
- Check if the starting point of the trace can be changed over the whole range of 24 divisions when operating the LEVEL control (R4).

3.2.4.3. *EXTERNAL LEVEL RANGE check*

- Apply to the EXTernal trigger input (X5) a sinewave voltage of 12 V p-p and a frequency of approx. 2 kHz
- Depress the EXT button of the trigger source selector (S16c)
- Check that when operating the LEVEL control (R4) the starting point of the trace is adjustable over the whole amplitude of the input signal.

3.2.4.4. *MAINS TRIGGERING check*

- Put the CH. A AMPL/DIV switch (S5) in the 50 mV/DIV position
- Put the TIME/DIV switch (S7) in the 10 ms/DIV position
- Apply a mains related signal of 10 mV to the CH. A input (X2)
- Depress button A on the trigger source selector (S16a)
- Because the amplitude on the screen is too small, triggering is not possible.
- Depress button A and B on the trigger source selector together (S16a and S16b) and check that stable triggering occurs.

3.2.4.5. *TRIGGER SENSITIVITY check*

- Adjust the TIME/DIV switch (S7) so that several sinewaves are written.
- Put the CH. A and CH. B AMPL/DIV switch in the 100 mV/DIV position.
- Check the trigger sensitivities according to the following table.

Trigger source (depress button ...)	AUTO/LEVEL operation	Input signal (sinewave)		
		Freq.	amplitude peak/peak	applied to socket
CH. A (S16a)	AUTO	100 Hz	75 mV	X2 (CH. A)
		5 MHz	75 mV	
		15 MHz	150 mV	
CH. B (S16b)	LEVEL	10 Hz	150 mV	X3 (CH. B)
		5 MHz	75 mV	
		15 MHz	150 mV	
EXT input (S16c)	LEVEL	10 Hz	0,8 V	X5 (EXT)
		15 MHz	1,4 V	

Trigger source (depress button ...)	TV operation	Video input signal	
		sync pulse amplitude peak/peak	applied to socket
CH. A (S16a)	TV	75 mV	X2 (CH. A)
EXT. input (S16c)	TV	0,8 V	X5 (EXT.)

3.2.4.6. *TIME COEFFICIENT adjustment (R504, R527)*

- Put the TIME/DIV switch (S7) in the 5 μs/DIV position
- Apply to the CH. A input (X2) a pulse voltage with an accurate repetition rate of 5 μs
- Adjust the CH. A AMPL/DIV switch (S5) so that the time marker signal is displayed at a reasonable trace height (about 3 divisions)
- Depress the A button on the trigger source selector (S16a)
- Adjust R504 (marked 5 μsec) so that the central 8 periods occupy 8 divisions.
- Put the TIME/DIV switch (S7) in the 5 ms/DIV position.
- Apply to the CH. A input (X2) a pulse voltage with an accurate repetition rate of 5 ms.
- Adjust R527 (marked 5 msec) so that the central 8 periods occupy 8 divisions.
- Put the TIME/DIV switch (S7) in the 5 μs/DIV position and apply a signal with a repetition rate of 5 μs.
- Turn the VARIABLE TIME/DIV control (R10) fully anti clockwise and check if this control has a range between 1:2,6 and 1:3,5.
- Put the VARIABLE TIME/DIV control (R10/S8) in the CAL position.
- Pull the X MAGN control (S1)
- Put the TIME/DIV switch (S7) in the 10 μs/DIV position and apply a signal with a repetition rate of 2 μs.
- Check that there are 8 periods that have a width of 8 divisions with a tolerance of + or – 0,4 division.
- Check that the beginning of the trace can be made visible when operating the X POSITION control (R3).
- Depress the X MAGN control (S1) and check all the remaining TIME/DIV switch positions.
- Check that the central 8 periods occupy 8 divisions (+ or – 0,24 div) and that at least 10 divisions are visible on the screen.

3.2.4.7. *HORIZONTAL SENSITIVITY check*

- Put the TIME/DIV switch (S7) in the X VIA B position
- Put the CH. B AMPL/DIV switch in the 0,1 V/DIV position
- Apply to the CH. B input (X3) a 600 mV sinewave with a frequency of approx. 2 kHz.
- Check that the horizontal deflection is 6 divisions with a tolerance of + or – 1 division.

3.2.4.8. *HORIZONTAL BANDWIDTH check*

- Settings of controls as described above.
- Adjust the amplitude of the 2 kHz signal so that a horizontal deflection of 6 divisions is obtained.
- Increase the frequency to 1 MHz and check if the horizontal deflection is at least 4,2 divisions.

3.2.4.9. *PHASE DIFFERENCE BETWEEN X AND Y CHANNELS check*

- Put the TIME/DIV switch (S7) in the X VIA B position
- Put the CH. A and CH. B AMPL/DIV switches in the 0,1 V/DIV position.
- Apply to the CH. A and CH. B inputs the same sinewave of 600 mV/2 kHz
- Check that a straight line is displayed under an angle between 40° and 50° (typical 45°) with the horizontal graticule lines as indicated in Fig. 3.8.
- Apply to the CH. A and CH. B inputs the same sinewave of 600 mV/50 kHz.
- Check that the phase error between the horizontal and vertical channel does not exceed 3°/0,3 divisions (see Fig. 3.7.).

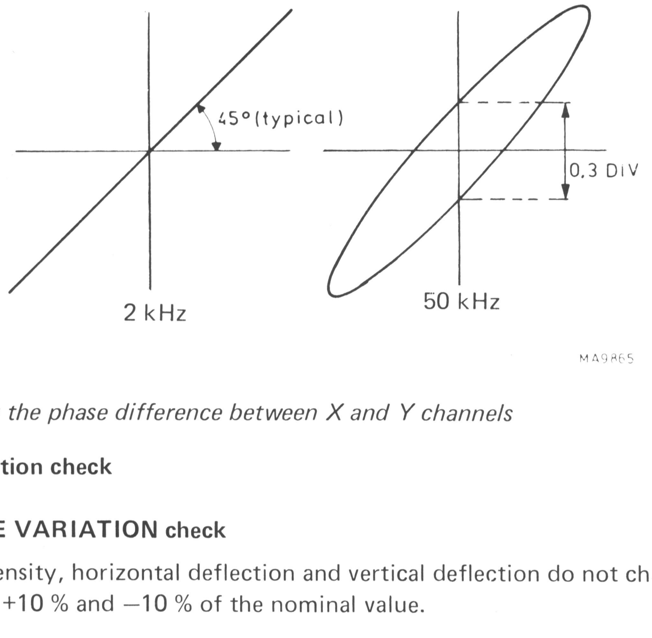


Fig. 3.8. Checking the phase difference between X and Y channels

3.2.5. **Mains voltage variation check**

3.2.5. MAINS VOLTAGE VARIATION check

Check that the intensity, horizontal deflection and vertical deflection do not change when varying the mains voltage over +10 % and –10 % of the nominal value.

3.3. CIRCUIT DESCRIPTION (See Fig. 3.19)

3.3.1. Vertical deflection

As far as channel A and B are identical only channel A is described.

INPUT COUPLING STAGE

In the DC position (S9 released) the signal applied to input socket X2 reaches the high impedance attenuator via R51.

In the AC position (S9 depressed) the signal applied to X2 reaches the high impedance attenuator via R51 and blocking capacitor C51.
R52 discharges C51 when switching S9 from AC to DC position.

Depressing the 0-button (S10) earthens the attenuator input. In this position the signal applied to X2 is connected to ground via R51, C51 and R52.

Note that R51 (CH. A) and R151 (CH. B) don't have the same value. This difference makes the bandwidth of both channels equal. This is done because CH. A and CH. B are somewhat different: CH. A has a variable gain and CH. B has a normal/invert function.

HIGH IMPEDANCE ATTENUATOR

This block contains the 1, 10 and 100 times attenuator.

The 100 times attenuator is active in the 10, 5 and 2 V/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R54, R57, R58 and parallel capacitors in order to obtain an attenuation coefficient of 100.
Variable capacitor C61 makes adjusting possible of the square wave response of this section.

The 10 times attenuator is active in the 1, 0.5 and 0.2 V/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R53, R56, R58 and parallel capacitors in order to obtain an attenuation coefficient of 10.
Variable capacitor C59 makes adjusting possible of the square wave response of this section.

A 1 time attenuator is active in the 100, 50 and 20 mV/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R60, R58. R60 limits the current in V201 if HF signals with a high amplitude are applied to the input of the instrument.

Another 1 time attenuator is active in the 10, 5 and 2 mV/DIV attenuator switch (S5) positions: the output signal from the coupling stage is applied to the attenuator section consisting of R55, R58. R55 limits the current in V201 if HF signals with a high amplitude are applied to the input of the instrument.

Note that the attenuator coefficient is the same as used in the 100, 50 and 20 mV/DIV positions.
The necessary sensitivity in the 10, 5 and 2 mV/DIV positions is obtained by a 10 times gain increase in the PREAMPLIFIER block.

PREAMPLIFIER (V202, V203, V211, D201)

The output of the HIGH IMPEDANCE ATTENUATOR reaches via R59, C63 and R201 the input of a symmetrical impedance converter, which consists of two matched FET's V202 in source follower configuration.
The DC BALANCE of this stage can be adjusted with the front panel potentiometer R7.
Diode V201 protects the FET input against excessive negative voltages.

The heart of the preamplifier is formed by integrated circuit D201. A simplified diagram of this IC and matched discrete components is indicated in Fig. 3.9. The preamplifier is now discussed in the following sentences.

The source signals from V202 reach the base of the input stages V15/V16 and V18/V17 (pin 3 and 6) of integrated circuit D201. The emitters of the transistors V16 and V17 are connected via pin 4 and 5 to a switcheable resistor network R213, R214, R216 and R217. This network receives current from a constant current source with transistor V203.
The resistor network makes the 1-2-5 attenuator sequence:

- R213 and R214 always are in the circuit.
  These resistors determine the amplification of the input stage of D201 in the attenuator switch positions 10 V, 1 V, 100 mV and 10 mV/DIV. In these positions R216 and R217 are not switched in the circuit.
- When R216 is switched into the circuit (S5/o, m closed) the amplification of the input stage of D201 increases 2 times. This takes place in the attenuator positions 5 V, 0.5 V, 50 mV and 5 mV/DIV.

- When R217 is switched into the circuit (S5/o, n closed) the amplification of the input stage of D201 increases 5 times. This takes place in the attenuator positions 2 V, 0.2 V, 20 mV and 2 mV/DIV.

Inside D201 the collector current from the input stages V15/V16 and V18/V17 flows through the transistors V13 and V14. These transistors operate in a common base configuration and their base is kept at a fixed voltage of +5,3 Volt if pin 9 receives a supply voltage of +9.8 Volt made by V211 and matched components.

The collector current from V13 and V14 reaches the transistors V7 and V8 via the 150 Ohm resistors R3 and R4. These transistors also work in a common base configuration and their base is kept at a fixed voltage of +8,3 Volt if pin 9 receives a supply voltage of +9,8 Volt.

A X10 GAIN increase for the three most sensitive attenuator switch positions occurs when pin 2 switches from eath to floating condition.
Inside D201 current source CS2 is activated if pin 2 is not connected to earth. Therefore the amplifier stage with the transistors V9/V10 and V12/V11 is activated. This stage receives the signal on R3 and R4 on its inputs. This gives a collector current which is nine times stronger than the collector current from V7 and V8. Both collector currents are added so that the gain increases ten times.

The GAIN X10 ADJUSTMENT is achieved by potentiometer R223 which is incorporated in the circuit connected to pin 7 and 8. Pin 7 and 8 are inside D201 connected to the emitter of V10 and V11 in the nine times amplifier stage.
In channel B does this circuit also incorporate the channel B NORMAL/INVERT BALANCE (R319).

The collector current from V7 and V8 and eventually (GAIN X10 mode) V10 and V11 reaches via R1 and R2 the emitters of a multiplier stage with V1/V2 and V3/V4. This multiplier stage is in channel A used for the GAIN X1 ADJUSTMENT and in channel B for the NORMAL/INVERT function.
NORMAL mode: pin 11 is floating and pin 10 connected to +12 Volt so that V2 and V3 are not conductive and V1 and V3 are conductive.
Now the emitter current of V1 reaches pin 13 and the emitter current of V4 reaches pin 12.
INVERT mode: pin 10 is floating and pin 11 is connected to +12 V so that V1 and V4 are not conductive and V2 and V3 are conductive.
Now the emitter current of V2 reaches pin 12 and the emitter current of V3 reaches pin 13.
Channel A: V1, V2, V3 and V4 are all more or less conductive. The gain can be adjusted by varying the conductivity of V1 and V4 with the base circuit with R241 and potentiometer R8.

The output pins of D201 are 13 and 12.
They are connected to emitter of transistor V219 and V221 in the channel switch.
Note that in the X1 GAIN position the current applied to the pins 13 and 12 is equivalent to the output current at pin 4 and 5.

The transistors V5, V6 and current source CS1 are used to drive the trigger pick off amplifiers via pin 15 and 14. In channel A pin 14 is not in use and connected to +12 Volt.

CHANNEL SWITCH (V219, V221)

This block is able to switch - depending on the output signal from the channel multivibrator - the signal on pin 13 and 12 of D201 through to the final Y-amplifier.
Diode V214 and V253 keep the voltage on the anodes of V216 and V218 at a fixed voltage of 11,3 Volt (provided the supply voltage is exact 12 Volt).

Ch. A switched off: the channel multivibrator output D101/6 is L. Zenerdiode V103 is conductive and diode V217 is not conductive. Also the transistors V219 and V221 are not conductive. The output signal from D201 does not reach the final Y-amplifier: the current which flows into the outputs of D201 (pin 13 and 12) is supplied by the diodes V216 and V218.
Ch. A switched on: the channel multivibrator output D101/6 is H. Zenerdiode V103 is not conductive and diode V217 is conductive. Also the transistors V219 and V221 are conductive. The output signal from pin 13 and 12 of D201 reaches the inputs of the final Y-amplifier: the current which flows into the outputs of D201 is supplied by the emitters of V219 and V221.

FINAL Y AMPLIFIER (V266) V267, V268, V270 ... V279)

The input stage consists of a series feedback stage with transistor V267 balanced by transistor V268. This stage has adjustment points for Ch. B gain adjustment (R274) and square wave compensation (C266).
Transistor V266 functions as a voltage source of which the emitter voltage becomes a little more postive in the ADDed mode because of R265 and S3. The current applied to the inputs of the final amplifier doubles in ADDed mode: Ch. A and Ch. B are both switched on. Without the compensation achieved by S3 , R265 and

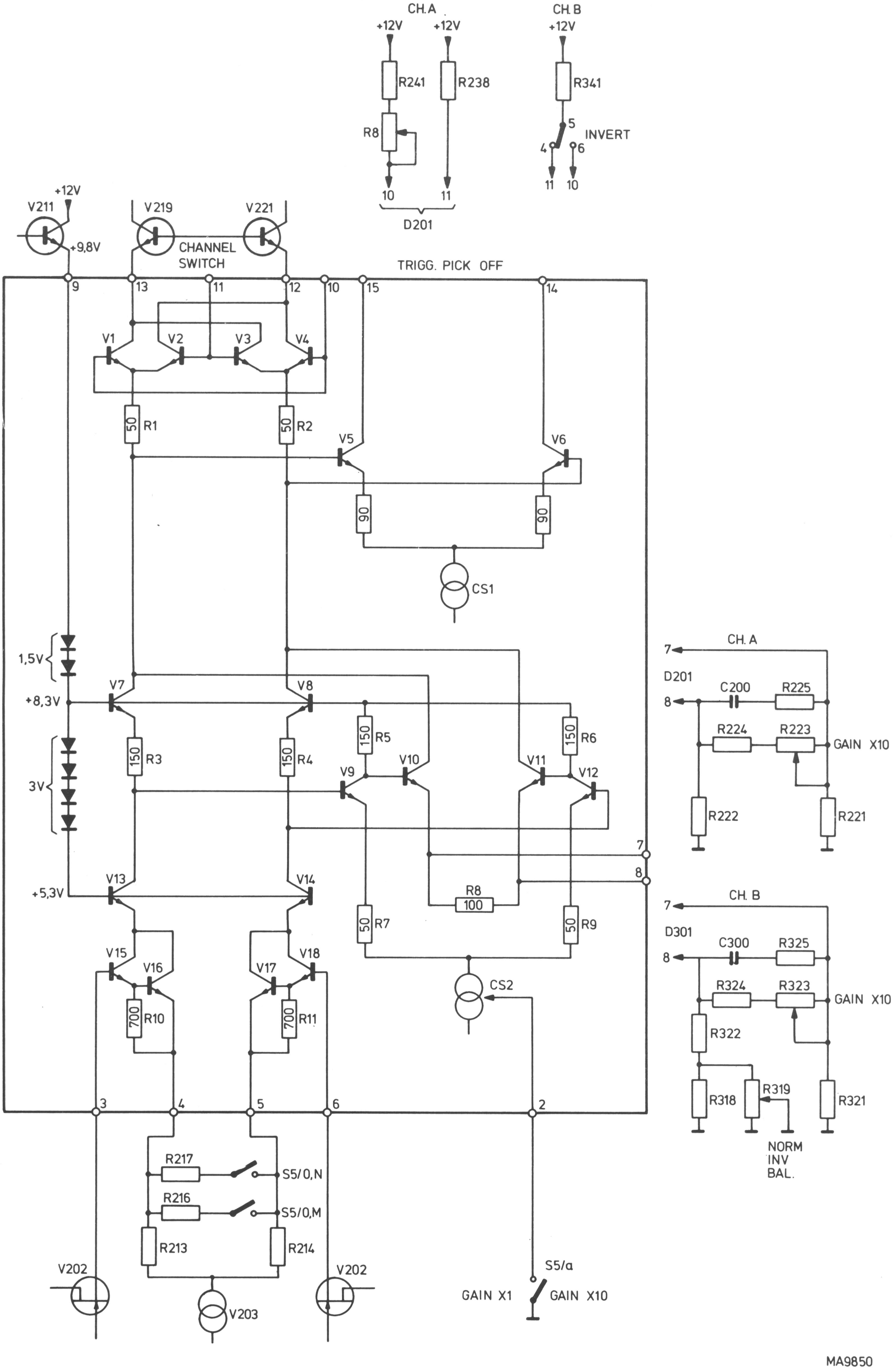


Fig. 3.9. Simplified circuit diagram of D201/D301

V266 the gain would decrease a little.
The input stage is located on the main unit and the other parts are located on the final amplifier unit. The interconnections between both units are made by means of two coaxial cables. V278 and V279 form a common base circuit between the coaxial cables and output stage.
The output stage consists of V270, V271, V272 and V273 that drive deflection plate Y2 balanced by V274, V275, V276 and V277 that drive deflection plate Y1. The deflection plates are not driven directly from the amplifier; but via R292 and R293 in order to increase stability.
In the section that drives Y2, V272 and V273 function as a current source. Two transistors are used because of maximum permissible current and voltage on each transistor and to reduce stray capacitances. V270 and V271 form a shunt feedback stage in which two transistors are used because of maximum permissible current and voltage on each transistor and to reduce stray capacitances.

In the section that drives Y1 are V274 and V275 the current source and V276 and V277 are the shunt feedback stage.

CHANNEL MULTIVIBRATOR (D101, D102)

The logic circuitry which is used in this unit can have two logic in or output levels:
a low level (indicated as L) between 0 and 0.8 V and a high level (indicated as H) between 2 and 5 Volt.
The unit incorporates 4 nand gates D101 and 2 flip-flops D102, of which one functions as an inverter.
The unit has two outputs that switch respectively channel A and channel B on (output = H) and off (output = L).
Output 6 of D101 switches channel A. Output 8 of D101 switches channel B.

The logic can occupy the following conditions depending on the position of the switches CH. A ON/OFF, CH. B ON/OFF, ADD, ALT/CHOP.

ADDed mode (S3 depressed): the nand gate inputs 4 and 10 of D101 are L. The nand gate outputs 6 and 8 are H and both channels are switched on at a time. Now addition takes place.

Ch. A ON (S11 depressed): the Clear input (pin 1) of the flip-flop D102 is L and the Preset input (pin 4) is H.
Therefore output Q (pin 5) is L and inverted output Q (pin 6) is H.
Now output 6 of nand gate D101 is H (Ch. A switched on) and output 8 of nand gate D101 is L (Ch. B switched off).

Ch. B ON (S13 depressed): the Preset input (pin 4) of the flip-flop D102 is L and the Clear input (pin 1) is H.
Therefore output Q (pin 5) is H and inverted output Q (pin 6) is L.
Now output 6 of nand gate D101 is L (Ch. A switched off) and output 8 of nand gate D101 is H (Ch. B switched on).

Ch. A ON, Ch. B ON and CHOPped mode (S11, S13 and S12 depressed):
The chopper oscillator D101/1, 2, 3 is switched on because pin 2 is H. This oscillator is a nand gate with RC feedback loop which produces a 500 kHz square wave signal at its output (pin 3). This output is H if the chopper oscillator is switched off in single channel or alternate operation.

The signal applied to the Clear input (pin 13) of D102 gives its inverse at the inverted Q output (pin 8) because the Preset input (pin 10) is L. This output signal is used to blank the display when switching over between the A and B channel.

The 500 kHz signal is also applied to input 13 of nand gate D101. Pin 12 of this gate is H in the chopped mode. In the chopped mode chopper pulses are present on pin 13 of D101. During the sweep the inverted chopper pulses reach the clock input (pin 3) of D102.
The Clear input (pin 1) and Preset input (pin 4) both are high; so they are inactive. Because of the feedback connection between inverted Q output (pin 6) and Data input (pin 2) the state of the flip-flop changes at avery positive transition of the clock input (pin 3). Because of these changes in the state of the flip-flop the display switches between the A and B channel with a frequency of 500 kHz.

Ch. A ON, Ch. B ON and ALTERNATE mode (S11 and S13 depressed).
Input 13 of nand gate D101/12, 13, 11 is H.
Input 12 of this gate is H during the time base sweep and L during the hold off period.
Therefore the Clock input (pin 3) of the flip-flop goes from L to H at the end of every sweep and the state of the flip-flop changes. Thus the display switches over from one channel to the other.

The following truth table indicates the level on some important points of the logic as a function of the display mode switches A on/off, B on/off, Chop/alt.

	D101/2	D101/12	D102/4 preset	D102/1 clear	D102/5 output	D102/6 inv. output
A on/B off	L	H	H	L	L	H
B on/A off	L	H	L	H	H	L
A and B on/Alt mode	L	sweep = H hold off = L	H	H	H/L	L/H (*1)
A and B on/Chop mode	H	H	H	H	H/L	L/H (*2)
A off/B off	L	H	H	H	H/L	L/H (*3)

*1) State changes at the end of every sweep
*2) State changes with a frequency of 500 kHz
*3) State is not defined.

3.3.2. HORIZONTAL DEFLECTION AND TIME BASE

CH. A TRIGGER PICK OFF (V209, V212)

The trigger signal current is picked off from pin 15 of D201 by means of the shunt feedback stage V209. This stage is followed by the series feedback stage V212, which is switched by means of the trigger source selector switch S16b. Transistor V212 and Diode V213 become conductive if S16b applies +12 Volt to R244, and the triggering signal current from channel A reaches the trigger source selector.
If S16b does not apply R244 to any potential V212 and V213 are not conductive and the triggering signal from channel A is blocked.
R247 functions than as a pull resistor for the collector of V212.

CH. B TRIGGER PICK OFF (V304, V306, V307, V309, V312)

V309, V312 and V313 have the same function as in Ch. A respectively V209, V212 and V213.
The channel B trigger pick off stage has also an output which is used to drive the horizontal amplifier in the X via B mode.
For this function are in use V304 balanced by V309 and V306 balanced by V307. The current from the collector of V307 feeds the X deflection selector.

EXTERNAL TRIGGER AMPLIFIER (V403, V404)

The signal applied to the external trigger input socket (X5) reaches a voltage divider network R403/C402, R404/C403. The output signal from the divider feeds via a DC blocking capacitor C404 two emitter followers V403 and V404 that work in cascade. Diode V402 protects transistor V403 against too positive input voltages.
When S16c on the trigger source selector (EXT.) is depressed the emitter of V404 receives emitter current from the +12 Volt supply via R409, C407 and R411. The emitter output signal is applied to R412 and DC blocking capacitor C409, that feeds the +/– slope selector.
The external input signal is blocked if S16c is released and V404 does not receive emitter current.

TRIGGER SOURCE SELECTOR

This unit is build up around the trigger selector switch S16a, b, c. The following sources can be selected:
Channel A (S16a depressed) or Channel B (S16b depressed):
See description "Channel A trigger pick off" or "Channel B trigger pick off". The output signal from V213 (Ch. A) or V313 (Ch. B) is split up into a DC component which flows into R401 and an AC component which flows via C406 to the input of the slope selector.
Zenerdiode V401 and R402 are necessary to suppress an eventual 100 Hz mains ripple from the power supply in the triggering signal.

External input signal (S16c depressed):
See description "External trigger amplifier".

Line signal (S16a and b depressed):
The line signal from the mains transformer T803 reaches via R816 a low pass filter consisting of C412, C411 and R414. This filtered signal is applied to the input of the slope selector via R412 and C409.

SLOPE SELECTOR (V451, V457)

The input signal first reaches a limiter consisting of the diodes V406 and V407.
This limiter is necessary if in the external trigger mode high amplitude signals are applied to the external input X5.

The output signal from the limiter circuit is applied to the base of shunt feedback amplifier V451.
The signal on the collector of this transistor is inverted by V457 so that there is a phase shift of 180 degrees between the collector signal of V451 and V457.
Negative slope: the anodes of diode V452 and V453 are connected to +12 V via R454 and S17.
These diodes are conductive and the collector signal from V451 is applied to the base of emitter follower V458. The anodes of diode V454 and V456 are connected to −12 V via R458 and S17.
Positive slope: the diodes V452 and V453 are not conductive and the diodes V454 and V456 are conductive so that the collector signal from V457 reaches the base of emitter follower V458.

TRIGGER COMPARATOR (V459, V461, V469, V467, V474, V472, V476)

The comparator function is achieved by V467 and V474. The output signal from the comparator is applied to a series feedback stage V472 and a shunt feedback stage V476. Those two stages together give a gain of 1,6 times.
The output signal from the emitter of V476 is applied to the sweep gating logic. The time base can start if the emitter of V476 goes from H to L.
The comparator can function in two modes:

AUTO mode with TOP leveling. The AUTO switch (S2) is closed so that V469 and V461 are conductive and V459 is not conductive.
The triggering signal which reaches the input of the comparator transistor V467 via C451 has a top level of about 8,3 Volt because of voltage divider R464 and R469 and the detection at the base of V467. Zenerdiode V471 and transistor V469 are conductive.
In the AUTO mode is the base of comparator transistor V474 applied to +12 Volt via diode V464 and S2. This comparator section and level potentiometer R4 are inoperative and diode V468 is not conductive. Diode V473 is incorporated to make the comparator symmetrical and protection of the base-emitter junction of V474 against too negative voltages.

NORMAL mode with level adjustment: V469 and V461 are not conductive and V459 is conductive.
The triggering signal which reaches the input of the comparator transistor V467 via C451 has an average value of about 1 Volt because of voltage divider R464, R469 and R467. R467 is switched on by transistor V459.

TV FILTER

The TV trigger unit contains a low-pass filter with two different cut-off frequencies. The filter is connected between the series feedback stage V472 and the shunt feedback stage V476 in the trigger comparator.
If the filter is switched on (S1A closed) the instrument functions in the AUTO mode with top leveling because V493 becomes conductive.
The unit contains two filter capacitors C491 and C492 that are switched into the circuit by respectively V491 and V492.
In the TIME/DIV switch positions 0,2 s ... 0,5 ms/DIV C491 and C492 are both switched into the circuit and triggering on frame pulses (TVF) is possible.
In the TIME/DIV switch positions 0,2 ms ... 0,5 μs/DIV: C492 and V492 are switched off because V496 and V495 become conductive: triggering on line pulses (TVL) is possible. Transistor V496 is operated by the TIME/DIV switch.

SWEEP GATING LOGIC (D501, D502, D503)

TIME BASE (V501, V502, V503, V504, V506, V507, V508)

HOLD OFF CIRCUIT (V511, V512, D501/12, 13, 11)

The three functional blocks mentioned above are not described separately because they function as an integral part. See Fig. 3.10 and Fig. 3.11 for circuit diagram detail and voltage waveforms.

The time base is build around the timing capacitors C502 – which is always in the circuit – and C503 which is switched in the circuit by V503 in the low sweep speeds 0,2 s ... 0,5 ms/DIV.
A constant current from current source V502 charges the capacitor(s) in order to produce a time linear voltage.
The TIME/DIV control (S7) is incorporated in the emitter of the current source.
The VARIABLE TIME/DIV control (R10) is incorporated in the base circuit of the current source.

The voltage on the base circuit of current source V502 in the TIME/DIV positions 0,2 s ... 0,5 ms/DIV is determined by the emitter voltage of V503.
This emitter voltage is adjustable with R527.
The voltage on the base circuit of V502 in the TIME/DIV positions 0,2 ms ... 0,5 μs/DIV is determined by the emitter voltage of V501.
This emitter voltage is adjustable with R504.

Charging of the time base capacitor(s) takes place during the time base sweep. In this situation is switching transistor V504, which is controlled by the sweep gating logic, not conductive. This transistor comes into conduction at the end of the sweep; discharges the timing capacitor(s) and takes over the current from V502. The switching transistor goes again out of conduction when the time base must run again.

The sawtooth voltage on the timing capacitors is picked off by two emitter followers V506 and V507 that are connected in cascade and applied to the X-deflection selector.

The output signal from V507 is also applied to emitter follower V512. This emitter follower feeds the hold-off capacitor(s). Capacitor C504 is always in the circuit and capacitor C506 is switched into the circuit by V511 in the sweep speeds from 0,2 s to 0,5 ms/DIV.

The sawtooth on the hold-off capacitor(s) is applied to the input of nand gate D501/12, 13, 11.
This gate is a Schmitt-trigger with a hysteresis of approximately 0,8 Volt. The output of the inverter becomes L if the positive going slope of the sawtooth reaches a level of about 1,8 Volt.

The two D type flip-flops D503 work in parallel.
The inverting output of one flip-flop (pin 6) feeds the switching transistor V504 and the inverting output of the other flip-flop (pin 8) feeds the Z amplifier.
When pin 8 is H the display is blanked.

D502 is a monostable multivibrator. The inverting output (pin 6) stays L during 100 msec. after reception of a positive going pulse on trigger inputs 3 and 4. This 100 msec. time is determined by C501. The inverting output (pin 6) becomes always H if the Clear input (pin 5) is L.

The three possible modes that are X via B, Auto and Normal mode are discussed separately:

X via B mode. Input 4 of D501 is L (because of conducting diode V500 –0,6 Volt) so that the trigger pulses on pin 5 of D501 are blocked.
Input 5 of D502 is L (–0,6 Volt) so that the inverting output (pin 6) is H. Thus input 9 of D501 is H.
Input 10 of D501 is H because the anode of diode V516 is about +12 Volt.
Now output 8 of D501 is L and a Preset command is given to the D flip-flops D503. The inverting outputs of the flip-flops are L. The L on pin 8 of D503 gives an unblanked display.

Auto mode without trigger pulses.
Input 4 of D501 is H via R502 so that trigger pulses on input 5 can reach the clock inputs of the flip-flops (pin 3 and 11). Input 5 becomes H when a trigger pulse is present; the clock inputs of the flip-flops become L then.
The flip-flops trigger on a positive going clock pulse.
The Clear input of monostable multivibrator D502 is H via R502 and inactive.
Input 9 of D501 is H if no trigger pulses are applied to input 5 of D502.
Now output 8 of D501 is L and a preset command is given to the flip-flops (pin 4 and 10). The flip-flops function in this situation as an inverter of which the Clear input (pin 1 and 13) signal reaches inverted the output pins 6 and 8.
If the time-base capacitor(s) are charging V504 is not conducting and output 6 of D503 is L.
Also the hold-off capacitors are charging and the voltage on input 12 and 13 of D501 is rising. If this voltage has reached a value of approximately 1,8 Volt the nand gate detects a H and its output becomes L. This L signal

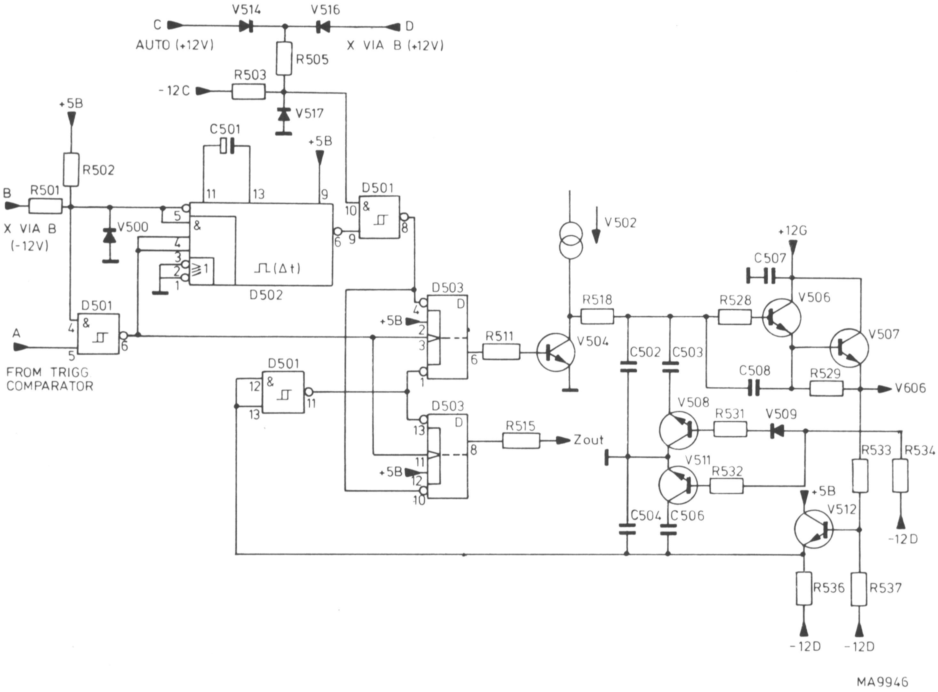


Fig. 3.10. Detail of sweep gating logic, time base and hold-off circuit

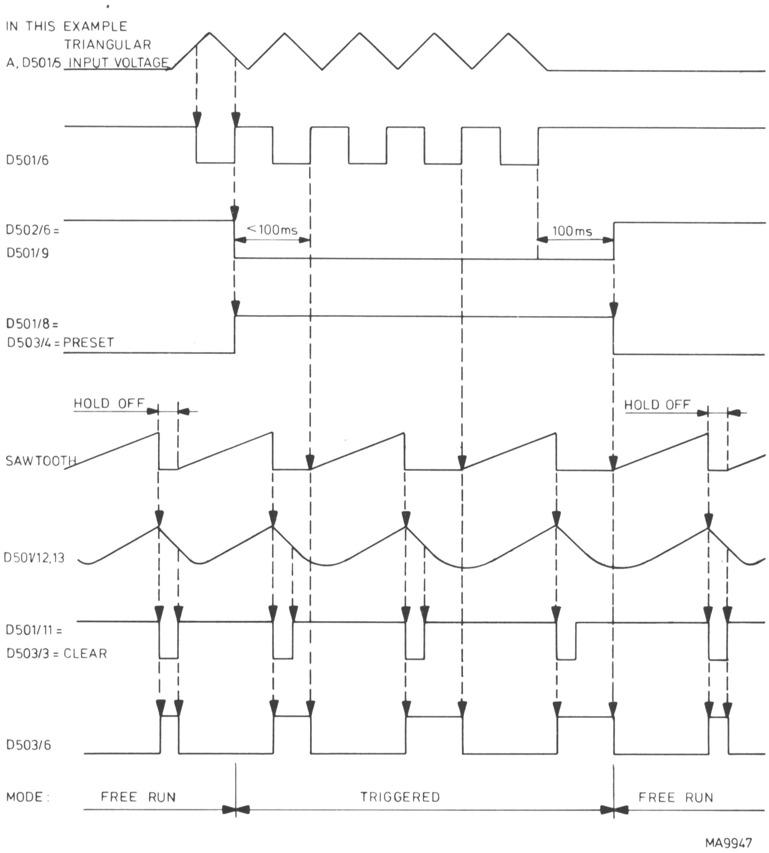


Fig. 3.11. Some voltage waveforms in the circuit shown in Fig. 3.10.

The circuit works in the auto mode and the time base runs free 100 ms after the last trigger pulse.

is applied to the Clear input of the flip-flops (pin 1 and 13). Because the flip-flops function as an inverter the output pins 6 and 8 become H and switching transistor V504 becomes conductive.
V504 discharges the time-base capacitor(s) and R536 discharges the hold-off capacitors. The voltage on input 12 and 13 of D501 decreases. If this voltage has reached a value of approximately 1 Volt output 11 of D101 becomes H again. Thus the output 6 and 8 of the flip-flops become L again and switching transistor V504 does not conduct anymore. The charging of the time-base capacitor(s) starts again, and so on: the time base runs free.

Auto mode with trigger pulses.
This mode is described as far as it is different from the "Auto mode without trigger pulses".
A positive going trigger pulse on output 6 of D501 triggers the monostable multivibrator D502 and its output (pin 6) becomes L for 100 msec. Thus pin 9 of D501 becomes L and the output H.
The Preset inputs of the flip-flops are not activated now, so that the flip-flops do not function as an inverter any longer. After discharge of the hold-off capacitor(s) the output of the flip-flops only become H at the reception of a positive going trigger pulse on the clock input (pin 3 and 11) so that the time base starts.
The behaviour in the Auto mode with and without trigger pulses is indicated in Fig. 3.11.

Normal mode with trigger pulses.
This mode is described as far as it is different from the "Auto mode without trigger pulses".
Input 10 of D501 is L and the output is H so that the Preset inputs of the flip-flops (pin 4 and 10) are inactive: the flip-flops do not function as an inverter as described in the AUTO mode. After discharge of the hold-off capacitor(s) the outputs of the flip-flops become L and only become H at the reception of a positive going trigger pulse on the clock inputs (pin 3 and 11) so that the time-base starts.

X-DEFLECTION SELECTOR (V602, V604, V605, V606, V607)

The output signal current from the Ch. B trigger pick off amplifier reaches the base of shunt feed-back stage V602.
The collector output signal from V602 is applied to the input of the final X-amplifier (base of V609) if the diodes V605 and V604 are made conductive.
This is done by pulling their cathodes to –12 Volt via R606 and a contact of the TIME/DIV switch, when this switch is in the X via B position. In the other switch positions the cathodes of V605 and V604 are pulled to +12 Volt by R606 and R610.
These diodes are not conductive then and the collector signal from V602 is blocked.
In the other switch positions are the diodes V606 and V607 conductive by pulling their cathodes to –12 Volt via R604 and a contact of the TIME/DIV switch. Now the time base sawtooth which is applied to the anode of V606 reaches the input of the final X-amplifier. In the X via B position is the sawtooth blocked because V606 and V607 are not conductive because their cathodes are pulled to +12 Volt via R604 and R603.

FINAL X-AMPLIFIER (V608, V609, V611, V612, V613, V614, V617, V618, V619)

The output signal from the X-deflection selector reaches the base of series feedback stage V608.
This stage is balanced by V611. The base circuit of this transistor incorporates the horizontal position control R3.
V608 and V611 receive their emitter-circuit from constant current source V609, via R618 and R619.
R618 and R619 are shunted by R621 in the X-magnifier X5 position so that a horizontal gain increase of 5 times is obtained.
The collector signal from V608 and V611 is fed via two coaxial cables to the output stage. This output stage consists of shunt feedback stage V614/V613 and current source V612, that drive the horizontal deflection plate X2.
The horizontal deflection plate X1 is driven by shunt feedback stage V617/V618 and current source V619.
In the shunt feedback stages V614/V613 and V617/V618 two transistors are used per stage because of maximum permissible current and voltage on each transistor and to reduce stray capacitances.
The horizontal deflection plates X1 and X2 are connected with the output stage via respectively R636 and R626 in order to increase stability.
Note that the horizontal output stage has a higher supply voltage than the vertical output stage.
This is because the horizontal deflection sensitivity is less (19 Volt/DIV) than the vertical sensitivity (9,5 Volt/DIV). Therefore the horizontal output stage must deliver a higher amplitude to the CRT for a certain deflection than the vertical output stage.

3.3.3. C.R.T. display section

Z-AMPLIFIER (V708, V709)

The input of the Z-amplifier is the cathode of V707 and receives signal from:

- The sweep gating logic in order to blank the display during the time base hold-off period.
- The channel multivibrator in order to blank the display in the chopped mode during the switching from one channel to the other.
- The intensity potentiometer R11 that influences the amount of current fed into the Z-amplifier.

The Z-amplifier is a shunt-feedback stage with V709 and V708.
The HF component in the output signal is fed via the 2 kV blocking capacitor C707 to the Wehnelt cylinder of the CRT.

MODULATOR (V701, V702)

The DC and LF components at the output of the Z-amplifier are fed to the modulator as a current to the emitter of V702. V701 and V702 form a 200 kHz multivibrator. The AC voltage on the collector of V702 has a peak to peak value which depends on the current fed to the emitter of V702.
The collector voltage of V702 is fed via the 2 kV blocking capacitor C703 to the demodulator.

DEMODULATOR (V704, V706)

The modulated LF and DC components in the Z-amplifier output are demodulated by the rectifier diodes V704 and V706 and smoothed by C704. The voltage on C704 is added to the cathode-voltage and after that added to the HF component and fed to the Wehnelt cylinder.

TRACE ROTATION (V711, V712)

The emitter followers V711 and V712 and preset potentiometer R6 determine the strength and sense of the current in the trace rotation coil L701.
Only one emitter follower is conductive at a time. Which emitter follower is determined by the position of R11.

3.3.4. POWER SUPPLY (V818, V819, V822, V823)

The mains voltage is transformed, rectified and smoothed to 46 Volt DC. The mains transformer is double insulated and equipped with a thermal fuse to protect the insulation against excessive temperatures.
The 46 Volt DC is applied to a regulated DC to AC balance converter. This converter incorporates the power transistors V818 and V819 with series feedback stabilisation. These transistors drive the power transformer T801 with a square wave signal of approximately 16 kHz. The base of the power transistors is driven by driver transformer T802 that works with a saturated core.
The regulator circuit incorporates V823 and V822 of which the collector is connected to the centre tap of T802.

The base current of V818 respectively V819 flows also through V822. Therefore, V822 can regulate the base current for the power transistors and thus the collector current. The collector-current influences the output voltage.
V822 is regulated by V823 which is regulated by the +12 Volt supply voltage. For instance if the +12 Volt increases the collector-current of V823 decreases.
As a result the collector-current of the power transistors decreases and also the output voltage decreases.
The power transformer T801 has a number of outputs that give the supply voltages for the instrument.
Bear in mind that the 6,3 Volt (CRT filament) is connected to −2 kV.

3.4. OPTIONAL EXTERNAL 24 V DC POWER SUPPLY

INTRODUCTION

This converter, which is available at the commercial department, enables the instrument to operate on an external DC supply voltage of 23 Volt, ± 10 %.
The external power source must be able to deliver a current of at least 1,2 A.
The optional unit is located above the normal power supply unit as shown in Fig. 3.12.

The external supply voltage is applied to the socket that can be mounted to the rear panel of the instrument.
The inner conductor of the socket must be connected to the negative pole and the outer conductor to the positive pole.
For external power supply the DC power input cord set with ordering number 4822 321 20125 can be used.

CIRCUIT DESCRIPTION

The unit converts 23 V DC into 46 V DC, which is the supply voltage of the instrument present on smoothing capacitor C824 in the power supply unit. The output of the converter is connected in parallel with the output of the bridge rectifier V828 in the power supply unit.
Fig. 3.23. shows the circuit diagram of the converter and Fig. 3.22. shows the components lay-out.
The active elements in the converter are V1001 and V1002 of which one is conductive at the time. The converter is of the sine-wave type. L1003 is a choke that supplies a constant current to the converter transformer T1001.
L1004 is a choke that supplies a constant current to smoothing capacitor C1004 and the load which is the instrument.

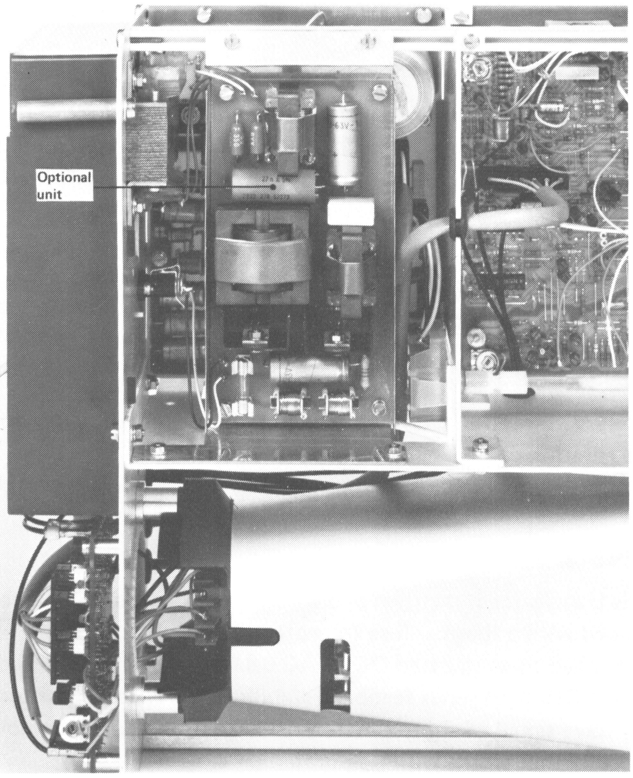


Fig. 3.12. Location of optional unit for external 24 Volt DC power supply.

HOW TO BUILD THE UNIT INTO THE OSCILLOSCOPE

- Remove the instrument covers as indicated in section 3.1.4. of this manual.
- Cut away so much material from the rear insulation plate that the external power socket can be mounted on the holes that are already present in the rear chassis plate.
- Mount the external power socket to the rear chassis plate with 2 screws M2x8, 2 washers, 2 spring-washers and 2 nuts.
- Solder the converter output wires in the holes already present in the power supply printed circuit board according to Fig. 3.20.
- Mount the converter to the centre chassis plate with 2 screws M3x6, 2 washers, 2 spring-washers and 2 nuts (see Fig. 3.21.).
- Mount the converter to the side profile with 2 screws M3x8, 2 washers, 2 spring-washers and 2 nuts (see Fig. 3.21.).
- Mount the instrument covers, and the instrument is ready for use.

PARTS LIST CONVERTER UNIT

Converter 24 V DC to 46 V DC.	5322 216 54185
Transistor BDX77	5322 130 44553
Diode BYX55/350	4822 130 30817
Fuse 2 A	4822 253 30025
DC power input socket	4822 265 20051
DC power input plug	4822 266 20014
DC power input cord set	4822 321 20125

3.5. INFORMATION FOR ASSISTENCE IN FAULT-FINDING

3.5.1. Voltages and waveforms

In the PM 3211(Q) circuit diagram (Fig. 3.19.) some DC voltage levels and waveforms are indicated in order to facilitate fault-finding. These voltages are typical values. Besides the waveforms in the PM 3211(Q) circuit diagram, some DC voltages and waveforms are shown in Fig. 3.9. and Fig. 3.11. in the circuit description.
For measurement of the DC voltages and waveforms in the circuit diagram the following settings of the controls are necessary:

- CH. A and CH. B switched ON.
- Instrument in ALTERNATE mode.
- X-POSITION control in the mid position.
- CH. A and CH. B POSITION controls in the mid position.
- Input coupling switches in the AC mode.
- AMPL/DIV: apply a 2 kHz square wave signal giving a vertical deflection of 6 divisions on one of the attenuator positions 10 mV/DIV, 0,1 V/DIV, 1 V/DIV or 10 V/DIV.
  For the waveform measurements 1 A, 2 A and 3 A the signal must be applied to the CH. A input socket.
  For the waveform measurements 1 B, 2 B and 3 B the signal must be applied to the CH. B input socket.
- Trigger source: CH. A.
- LEVEL control in the AUTO position.
- Trigger slope switch in the + position.
- TIME/DIV switch in the 0,1 ms/DIV position.
- VARIABLE TIME/DIV control in the AUTO position.

The settings of time base, attenuator and vertical position of the measuring oscilloscope are indicated next to the waveform. The measuring oscilloscope must be equipped with a 10:1 attenuator probe.

3.5.2. Repair in a Philips Service workshop

In case a defect is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a Philips Service Workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the fault found, or the service required.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consulation with the local PHILIPS Organization.

3.6. PARTS LIST AND DIAGRAMS

Mechanical parts, front panel (Fig. 3.13.)

Item	*Designation*	*Ordering number*	*Quantity*
1	Front frame, alluminium	5322 464 94002	1
2	Screen bezel	5322 450 74009	1
3	Screen bezel clamping spring	5322 492 64629	2
4	Contrast filter, blue	5322 480 34074	1
5	Graticule plate	5322 450 64092	1
6	LED holder	5322 255 44088	1
7	Calibration terminal	5322 264 24015	1
8	Grommet for cal. terminal	5322 325 84013	1
9	Knob 10 mm dia, screw mount	5322 414 34091	1
10	Knob cover, grey with line	5322 414 74015	7
11	Knob 10 dia, spring mount	5322 414 34134	6
12	Spring for knob	5322 492 64337	6
13	Textplate PM 3211	5322 455 84069	1
14	Textplate mounting nut	5322 505 14228	3
15	Switch knob	5322 414 34079	3
16	Cover for switch knob	5322 414 74019	3
17	Pushbutton grey/green	5322 414 25613	6
18	Pushbutton grey	5322 414 14011	7
19	BNC connector complete	5322 267 10004	3
20	Earthing terminal	5322 535 84346	1
21	Knurled nut for earthing terminal	5322 505 14178	1
22	Heaxgonal nut for earthing terminal	5322 506 14005	1
23	Front cover PM 3211	5322 464 94004	1
24	Grip profile	5322 466 64162	1
25	Adapter BNC/4 mm banane	5322 263 24005	1
26	Rubber foot	5322 462 44297	4
27	Handle arm	5322 498 54072	2
28	Pushbutton knob	5322 414 64053	2
29	Self-tapping screw	4822 502 30004	2
30	Washer	4822 532 10582	2
31	Bearing bush, plastic	5322 520 14267	2
32	Spring	5322 530 84075	2
33	Ratchet	5322 528 34128	2
34	Wrap around cover	5322 447 94366	1

Mechanical parts, rear panel (Fig. 3.14.)

Item	*Designation*	*Ordering number*	*Quantity*
35	Rear frame, alluminium	5322 464 94001	1
36	Coin slot screw	5322 500 14228	2
37	Circlip for coin slot screw	4822 530 70126	2
38	Mains section cover, plastic	5322 466 34012	1
39	Rear plate, plastic	5322 464 94005	1
40	Rear plate foot	5322 462 44298	2
41	Mains cable, European plug	4822 321 10084	1
42	Mains cable, USA plug	5322 321 14021	1
43	Mains voltage adapter	4822 272 10079	1

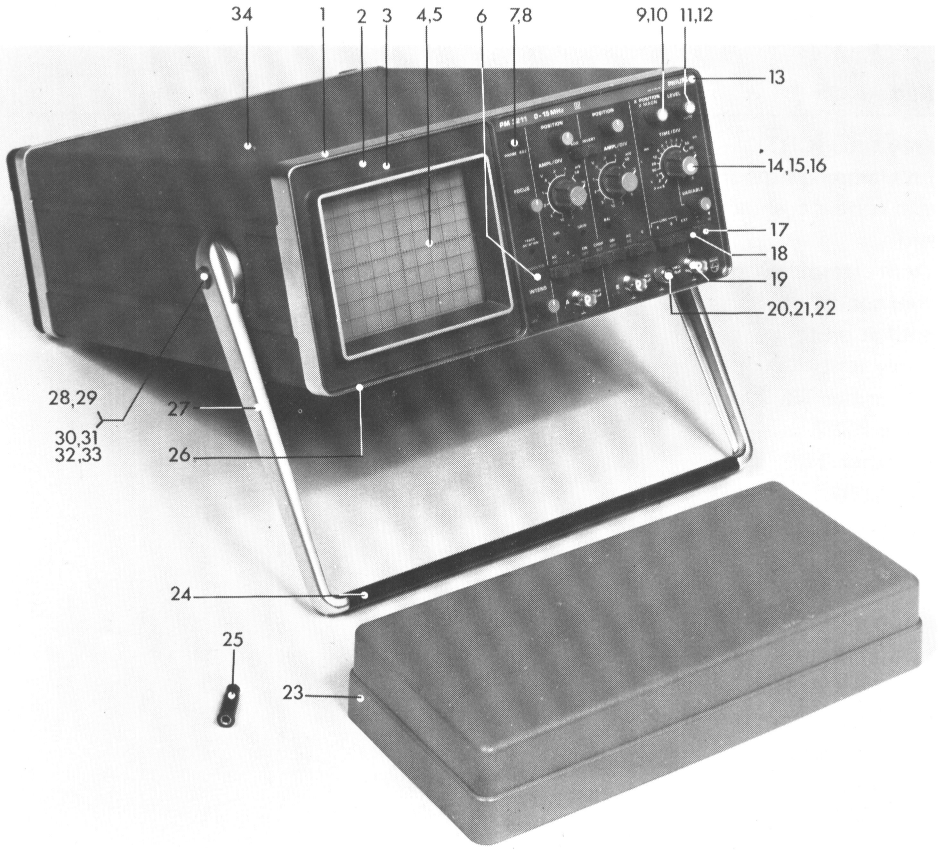


Fig. 3.13. Mechanical parts, front view

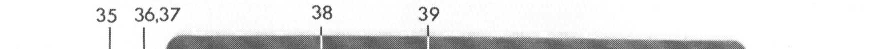


Fig. 3.14. Mechanical parts, rear view

Miscellaneous

Designation	*Ordering number*	*Quantity*
Cathode ray tube (CRT)	5322 131 24048	1
CRT front clamping support; plastic with rubber cushions	5322 381 14151	2
CRT shield	5322 462 54154	1
CRT bottom clamping spring	5322 401 14256	1
CRT rubber socket	5322 255 34095	1
Final amplifier unit	5322 216 54183	1
Power supply unit	5322 216 54182	1
Mains transformer T803	5322 146 14138	1
Thermal fuse F802	4822 252 20007	1
Converter transf. T801	5322 146 24192	1
Base transf. T802	5322 146 14151	1
High tension cable, complete	5322 320 24011	1
Attenuator switch (S5/S6)	5322 105 34045	2
Time base switch (S7)	5322 105 34046	1
2 pushbutton unit (S3/S4)	5322 276 24046	1
11 pushbutton unit (S9 ... S17)	5322 276 84064	1
Self-releasing pushbutton segment	5322 276 14102	10
Mutual-releasing push-button segment	5322 276 14117	3
3 pole socket "stocko"	4822 265 30121	2
3 pole plug "stocko"	4822 266 30071	2
4 pole socket "stocko"	4822 265 30123	1
4 pole plug "stocko"	4822 266 30072	1
6 pole socket "stocko"	4822 265 30117	1
6 pole plug "stocko"	4822 266 30073	1
7 pole socket "stocko"	4822 265 40119	1
7 pole plug "stocko"	4822 266 40057	1

Integrated circuits

Designation	*Ordering number*	*Quantity*
Vertical amplifier OQ0017	5322 209 85627	2
N74LS 132N	5322 209 85201	2
N7474N	5322 209 84165	2
N74 122N	5322 209 84231	1

CAPACITORS

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS			
C 51	4822 121 40349				POLYESTER FOIL	22 NF	10	400
C 52	4822 122 31194	8,2PF	0,25PF	500	CERAMIC PLATE			
C 53	4822 122 31194	8,2PF	0,25PF	500	CERAMIC PLATE			
C 54	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE			
C 56	4822 122 31187	2,7PF	0,25PF	500	CERAMIC PLATE			
C 57	4822 122 31054	10PF	2	100	CERAMIC PLATE			
C 58	4822 122 31222	220PF	2	100	CERAMIC PLATE			
C 59	4822 125 50045				TRIMMER	22 PF	–	250
C 61	4822 125 50017				TRIMMER	65 PF	–	250
C 62	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE			
C 63	4822 121 40338				POLYESTER FOIL	2,2 NF	10	630
C 101	4822 122 31175	1NF	10	100	CERAMIC PLATE			
C 103	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 104	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 106	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 107	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 151	4822 121 40349				POLYESTER FOIL	22 NF	10	400
C 152	4822 122 31194	8,2PF	0,25PF	500	CERAMIC PLATE			
C 153	4822 122 31194	8,2PF	0,25PF	500	CERAMIC PLATE			
C 154	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE			
C 156	4822 122 31187	2,7PF	0,25PF	500	CERAMIC PLATE			
C 157	4822 122 31054	10PF	2	100	CERAMIC PLATE			
C 158	4822 122 31222	220PF	2	100	CERAMIC PLATE			
C 159	4822 125 50045				TRIMMER	22 PF	–	250
C 161	4822 125 50017				TRIMMER	65 PF	–	250
C 162	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE			
C 163	4822 121 40338				POLYESTER FOIL	2,2 NF	10	630
C 200	4822 122 31174	2,7NF	10	100	CERAMIC PLATE			
C 201	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 202	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 203	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 205	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 264	4822 122 31063	22PF	2	100	CERAMIC PLATE			
C 265	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 266	4822 125 50045				TRIMMER	22 PF	–	250
C 267	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE			
C 268	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE			
C 269	5322 121 44025				POLYESTER FOIL	33 NF	10	400
C 272	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE			
C 273	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE			
C 274	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 300	4822 122 31174	2,7NF	10	100	CERAMIC PLATE			
C 301	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 302	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 303	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 304	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			
C 305	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 306	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 401	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 402	4822 122 31201	27PF	2	500	CERAMIC PLATE			
C 403	4822 122 31085	150PF	2	100	CERAMIC PLATE			
C 404	4822 121 40427				POLYESTER FOIL	220 NF	10	100
C 406	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 407	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 409	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			
C 411	4822 124 20584	2,2UF	-10+50	63	ELECTROLYTIC			
C 412	4822 121 40427				POLYESTER FOIL	220 NF	10	100
C 451	5322 121 40283				POLYESTER FOIL	3,3 UF	10	100
C 491	4822 122 31175	1NF	10	100	CERAMIC PLATE			
C 492	5322 121 44201				POLYESTER FOIL	10 NF	10	400
C 501	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC			
C 502	4822 121 50415				POLYSTYRENE FOIL	2,2 NF	1	63
C 503	5322 121 44246				POLYESTER FOIL	2,2 UF	5	100
C 504	4822 122 31175	1NF	10	100	CERAMIC PLATE			
C 506	4822 121 40257				POLYESTER FOIL	330 NF	10	100
C 507	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 508	4822 122 30027	1NF	-20+80	40	CERAMIC PLATE			
C 509	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 601	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 602	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE			
C 603	5322 121 44025				POLYESTER FOIL	33 NF	10	400
C 604	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE			
C 606	5322 121 44025				POLYESTER FOIL	33 NF	10	400
C 701	4822 122 30128	4,7NF	10	100	CERAMIC PLATE			
C 703	5322 122 54019	470PF	10	2000	CERAMIC DISK			
C 704	4822 122 31081	100PF	2	100	CERAMIC PLATE			
C 706	4822 121 40354				POLYESTER FOIL	1,5 NF	10	1600
C 707	5322 122 54019	470PF	10	2000	CERAMIC DISK			
C 708	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			
C 801	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC			
C 802	5322 122 54019	470PF	10	2000	CERAMIC DISK			
C 803	5322 122 54022	10NF	-20+50	2K	CERAMIC DISK			
C 804	5322 122 54022	10NF	-20+50	2K	CERAMIC DISK			
C 806	5322 122 54022	10NF	-20+50	2K	CERAMIC DISK			
C 807	5322 122 54022	10NF	-20+50	2K	CERAMIC DISK			
C 808	5322 122 54022	10NF	-20+50	2K	CERAMIC DISK			
C 809	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC			
C 811	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			
C 812	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC			
C 813	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS			
C 814	4822 124 20457	470UF	-10+50	6,3	ELECTROLYTIC			
C 816	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC			
C 817	4822 124 20501	47UF	-10+50	63	ELECTROLYTIC			
C 818	4822 124 20501	47UF	-10+50	63	ELECTROLYTIC			
C 819	4822 124 20308	6,4UF	-10+50	150	ELECTROLYTIC			
C 821	4822 124 20308	6,4UF	-10+50	150	ELECTROLYTIC			
C 822	4822 121 41134				POLYESTER FOIL	10 NF	10	250
C 823	4822 121 40427				POLYESTER FOIL	220 NF	10	100
C 824	5322 124 74072	2200UF	-10+50	63	ELECTROLYTIC			
C 825	5322 121 40233				POLYESTER FOIL	680 NF	10	100
C 826	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 827	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			
C 828	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 829	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC			
C 831	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 832	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 833	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 834	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 836	4822 124 20477	47UF	-10+50	25	ELECTROLYTIC			
C 837	4822 124 20477	47UF	-10+50	25	ELECTROLYTIC			
C 838	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC			
C 839	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 840	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 841	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE			
C 842	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 843	4822 124 20584	2,2UF	-10+50	63	ELECTROLYTIC			
C 844	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC			
C 845	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			
C 846	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE			

RESISTORS

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS			
R 1		4,7K	20	0.1W	TRIMMING POTM	5322 101 24073		
R 2		4,7K	20	0.1W	TRIMMING POTM	5322 101 24073		
R 3	5322 101 64012	47K	20	0.1W	CARBON POTM LIN + SWITCH			
R 4	5322 101 44035	10K	20	0.1W	CARBON POTM LIN + SWITCH			
R 5	4822 101 20446	2,7M	20	1W	CARBON POTM LIN			
R 6	5322 101 20408	100K	20	0,1W	CARBON POTM LIN			
R 7	4822 101 20455	1K	20	0.1W	CARBON POTM LIN			
R 8	4822 101 20431	2,2K	20	0.1W	CARBON POTM LIN			
R 9	4822 101 20455	1K	20	0.1W	CARBON POTM LIN			
R 10	5322 101 44035	10K	20	0.1W	CARBON POTM LIN + SWITCH			
R 11	5322 101 24146	22K	20	0.05W	CARBON POTM LIN			
R 51	5322 116 54442	51,1	1	MR25	METAL FILM			
R 52	4822 110 63187	1M	5	CR25	CARBON			
R 53	5322 116 55211	909K	0,5	MR30	METAL FILM			
R 54	5322 116 54209				METAL FILM	992 K	1	M30
R 55	5322 116 50669	205	1	MR25	METAL FILM			
R 56	5322 116 55206	113K	0,5	MR25	METAL FILM			
R 57	5322 116 55285	10,1K	0,5	MR25	METAL FILM			
R 58	5322 116 54188	1M	1	MR30	METAL FILM			
R 59	5322 116 55208	205K	1	MR30	METAL FILM			
R 60	5322 116 50669	205	1	MR25	METAL FILM			
R 102	5322 116 50523	4,99K	1	MR25	METAL FILM			
R 103	5322 116 54606	7,15K	1	MR25	METAL FILM			
R 104	5322 116 54529	619	1	MR25	METAL FILM			
R 106	5322 116 54606	7,15K	1	MR25	METAL FILM			
R 107	5322 116 54549	1K	1	MR25	METAL FILM			
R 108	5322 116 50523	4,99K	1	MR25	METAL FILM			
R 109	5322 116 50523	4,99K	1	MR25	METAL FILM			
R 110	5322 116 50415	1,15K	1	MR25	METAL FILM			
R 111	5322 116 50523	4,99K	1	MR25	METAL FILM			
R 151	5322 116 50452	10	1	MR25	METAL FILM			
R 152	4822 110 63187	1M	5	CR25	CARBON			
R 153	5322 116 55211	909K	0,5	MR30	METAL FILM			
R 154	5322 116 54209				METAL FILM	992 K	1	MR30
R 155	5322 116 50669	205	1	MR25	METAL FILM			
R 156	5322 116 55206	113K	0,5	MR25	METAL FILM			
R 157	5322 116 55285	10,1K	0,5	MR25	METAL FILM			
R 158	5322 116 54188	1M	1	MR30	METAL FILM			
R 159	5322 116 55208	205K	1	MR30	METAL FILM			
R 160	5322 116 50669	205	1	MR25	METAL FILM			
R 201	5322 116 50506	154	1	MR25	METAL FILM			
R 202	5322 116 50506	154	1	MR25	METAL FILM			
R 203	5322 116 50479	15,4K	1	MR25	METAL FILM			
R 206	5322 116 50479	15,4K	1	MR25	METAL FILM			
R 207	5322 116 54665	40,2K	1	MR25	METAL FILM			
R 208	5322 101 14071	100K	20	0.5W	TRIMMING POTM			
R 209	5322 116 55296	523	0,5	MR25	METAL FILM			
R 211	5322 116 54606	7,15K	1	MR25	METAL FILM			
R 212	5322 116 55294	4,32K	0,5	MR25	METAL FILM			
R 213	5322 116 55293	274	0,5	MR25	METAL FILM			
R 214	5322 116 55293	274	0,5	MR25	METAL FILM			
R 216	5322 116 55296	523	0,5	MR25	METAL FILM			
R 217	5322 116 55287	121	0,5	MR25	METAL FILM			
R 221	5322 116 54562	1,4K	1	MR25	METAL FILM			
R 222	5322 116 54562	1,4K	1	MR25	METAL FILM			
R 223	5322 100 10112	1K	20	0,5W	TRIMMING POTM			
R 224	5322 116 54469	100	1	MR25	METAL FILM			

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 225	5322 116 54558	8,25K	1	MR25	METAL FILM
R 234	5322 116 54519	402	1	MR25	METAL FILM
R 236	5322 116 50415	1,15K	1	MR25	METAL FILM
R 237	5322 116 50414	2,87K	1	MR25	METAL FILM
R 238	5322 116 54519	402	1	MR25	METAL FILM
R 241	5322 116 54549	1K	1	MR25	METAL FILM
R 242	5322 116 54558	8,25K	1	MR25	METAL FILM
R 243	5322 116 50586	1,54K	1	MR25	METAL FILM
R 244	5322 116 54549	1K	1	MR25	METAL FILM
R 247	5322 116 54696	100K	1	MR25	METAL FILM
R 248	5322 116 50671	2,61K	1	MR25	METAL FILM
R 249	5322 116 50671	2,61K	1	MR25	METAL FILM
R 251	5322 116 54469	100	1	MR25	METAL FILM
R 252	5322 116 54469	100	1	MR25	METAL FILM
R 253	5322 116 54606	7,15K	1	MR25	METAL FILM
R 254	5322 116 54665	40,2K	1	MR25	METAL FILM
R 263	5322 116 54469	100	1	MR25	METAL FILM
R 264	5322 116 54469	100	1	MR25	METAL FILM
R 265	5322 116 54683	68,1K	1	MR25	METAL FILM
R 266	5322 116 54558	8,25K	1	MR25	METAL FILM
R 267	5322 116 54648	24,9K	1	MR25	METAL FILM
R 268	5322 116 54508	301	1	MR25	METAL FILM
R 269	5322 116 54508	301	1	MR25	METAL FILM
R 270	5322 116 54442	51,1	1	MR25	METAL FILM
R 271	5322 116 54558	8,25K	1	MR25	METAL FILM
R 272	5322 116 54558	8,25K	1	MR25	METAL FILM
R 273	5322 116 54469	100	1	MR25	METAL FILM
R 274	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 275	5322 116 54549	1K	1	MR25	METAL FILM
R 276	5322 116 54525	511	1	MR25	METAL FILM
R 277	5322 116 50415	1,15K	1	MR25	METAL FILM
R 278	5322 116 54011	5,62K	1	MR25	METAL FILM
R 279	5322 116 54011	5,62K	1	MR25	METAL FILM
R 280	5322 116 54011	5,62K	1	MR25	METAL FILM
R 281	5322 116 54619	10K	1	MR25	METAL FILM
R 282	5322 116 50669	205	1	MR25	METAL FILM
R 283	5322 116 54011	5,62K	1	MR25	METAL FILM
R 284	5322 116 54011	5,62K	1	MR25	METAL FILM
R 285	5322 116 54011	5,62K	1	MR25	METAL FILM
R 286	5322 116 54011	5,62K	1	MR25	METAL FILM
R 287	5322 116 54648	24,9K	1	MR25	METAL FILM
R 288	5322 116 50669	205	1	MR25	METAL FILM
R 289	5322 116 54011	5,62K	1	MR25	METAL FILM
R 291	5322 116 50415	1,15K	1	MR25	METAL FILM
R 292	5322 116 54508	301	1	MR25	METAL FILM
R 293	5322 116 54508	301	1	MR25	METAL FILM
R 301	5322 116 50506	154	1	MR25	METAL FILM
R 302	5322 116 50506	154	1	MR25	METAL FILM
R 303	5322 116 50479	15,4K	1	MR25	METAL FILM
R 306	5322 116 50479	15,4K	1	MR25	METAL FILM
R 307	5322 116 54665	40,2K	1	MR25	METAL FILM
R 308	5322 101 14071	100K	20	0.5W	TRIMMING POTM
R 309	5322 116 55296	523	0,5	MR25	METAL FILM
R 311	5322 116 54606	7,15K	1	MR25	METAL FILM
R 312	5322 116 55294	4,32K	0,5	MR25	METAL FILM
R 313	5322 116 55293	274	0,5	MR25	METAL FILM
R 314	5322 116 55293	274	0,5	MR25	METAL FILM
R 316	5322 116 55296	523	0,5	MR25	METAL FILM
R 317	5322 116 55287	121	0,5	MR25	METAL FILM
R 318	5322 116 54529	619	1	MR25	METAL FILM
R 319	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 321	5322 116 54562	1,4K	1	MR25	METAL FILM
R 322	5322 116 50415	1,15K	1	MR25	METAL FILM
R 323	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 324	5322 116 54469	100	1	MR25	METAL FILM
R 325	5322 116 54558	8,25K	1	MR25	METAL FILM
R 326	5322 116 54519	402	1	MR25	METAL FILM
R 327	5322 116 50414	2,87K	1	MR25	METAL FILM
R 328	5322 116 54549	1K	1	MR25	METAL FILM
R 329	5322 116 54524	499	1	MR25	METAL FILM
R 331	5322 116 54562	1,4K	1	MR25	METAL FILM
R 332	5322 116 54624	11,5K	1	MR25	METAL FILM
R 333	5322 116 54562	1,4K	1	MR25	METAL FILM
R 334	5322 116 54519	402	1	MR25	METAL FILM
R 336	5322 116 54549	1K	1	MR25	METAL FILM
R 337	5322 116 50414	2,87K	1	MR25	METAL FILM
R 339	5322 116 54442	51,1	1	MR25	METAL FILM
R 340	5322 116 54549	1K	1	MR25	METAL FILM
R 341	5322 116 54541	825	1	MR25	METAL FILM
R 342	5322 116 54558	8,25K	1	MR25	METAL FILM
R 343	5322 116 50586	1,54K	1	MR25	METAL FILM
R 344	5322 116 54549	1K	1	MR25	METAL FILM
R 345	5322 116 54442	51,1	1	MR25	METAL FILM
R 347	5322 116 54696	100K	1	MR25	METAL FILM
R 348	5322 116 50671	2,61K	1	MR25	METAL FILM
R 349	5322 116 50671	2,61K	1	MR25	METAL FILM
R 351	5322 116 54469	100	1	MR25	METAL FILM
R 352	5322 116 54469	100	1	MR25	METAL FILM
R 353	5322 116 54606	7,15K	1	MR25	METAL FILM
R 354	5322 116 54665	40,2K	1	MR25	METAL FILM
R 401	5322 116 54549	1K	1	MR25	METAL FILM
R 402	5322 116 54519	402	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 403	5322 116 55209	845K	1	MR30	METAL FILM
R 404	5322 116 55283	402K	1	MR25	METAL FILM
R 407	5322 116 54743	301K	1	MR25	METAL FILM
R 408	5322 116 54011	5,62K	1	MR25	METAL FILM
R 409	5322 116 50568	4,99	1	MR25	METAL FILM
R 411	5322 116 54011	5,62K	1	MR25	METAL FILM
R 412	5322 116 54534	681	1	MR25	METAL FILM
R 413	5322 116 54624	11,5K	1	MR25	METAL FILM
R 414	5322 116 54655	30,1K	1	MR25	METAL FILM
R 451	5322 116 50579	3,16K	1	MR25	METAL FILM
R 453	5322 116 54549	1K	1	MR25	METAL FILM
R 454	5322 116 50671	2,61K	1	MR25	METAL FILM
R 456	5322 116 50671	2,61K	1	MR25	METAL FILM
R 457	5322 116 50484	4,64K	1	MR25	METAL FILM
R 458	5322 116 50671	2,61K	1	MR25	METAL FILM
R 459	5322 116 54549	1K	1	MR25	METAL FILM
R 461	5322 116 50671	2,61K	1	MR25	METAL FILM
R 462	5322 116 54627	13,3K	1	MR25	METAL FILM
R 463	5322 116 54558	8,25K	1	MR25	METAL FILM
R 464	5322 116 54696	100K	1	MR25	METAL FILM
R 466	5322 116 54743	301K	1	MR25	METAL FILM
R 467	5322 116 54606	7,15K	1	MR25	METAL FILM
R 468	5322 116 54696	100K	1	MR25	METAL FILM
R 469	5322 116 54743	301K	1	MR25	METAL FILM
R 471	5322 116 50523	4,99K	1	MR25	METAL FILM
R 472	5322 116 50678	20,5	1	MR25	METAL FILM
R 473	5322 116 54557	1,21K	1	MR25	METAL FILM
R 474	5322 116 54557	1,21K	1	MR25	METAL FILM
R 476	5322 116 54011	5,62K	1	MR25	METAL FILM
R 477	5322 116 54643	20,5K	1	MR25	METAL FILM
R 478	5322 116 54643	20,5K	1	MR25	METAL FILM
R 479	5322 116 50523	4,99K	1	MR25	METAL FILM
R 480	5322 116 54643	20,5K	1	MR25	METAL FILM
R 481	5322 116 54549	1K	1	MR25	METAL FILM
R 482	5322 116 50675	2,26K	1	MR25	METAL FILM
R 483	5322 116 50675	2,26K	1	MR25	METAL FILM
R 485	5322 116 54657	31,6K	1	MR25	METAL FILM
R 486	5322 116 50671	2,61K	1	MR25	METAL FILM
R 487	5322 116 54558	8,25K	1	MR25	METAL FILM
R 491	5322 116 54619	10K	1	MR25	METAL FILM
R 492	5322 116 54619	10K	1	MR25	METAL FILM
R 493	5322 116 54619	10K	1	MR25	METAL FILM
R 494	5322 116 50481	22,6K	1	MR25	METAL FILM
R 501	5322 116 50671	2,61K	1	MR25	METAL FILM
R 502	5322 116 54619	10K	1	MR25	METAL FILM
R 503	5322 116 54655	30,1K	1	MR25	METAL FILM
R 504	5322 100 10114	4,7K	20	0.5W	TRIMMING POTM
R 505	5322 116 54624	11,5K	1	MR25	METAL FILM
R 506	5322 116 54665	40,2K	1	MR25	METAL FILM
R 507	5322 116 54665	40,2K	1	MR25	METAL FILM
R 508	5322 116 54627	13,3K	1	MR25	METAL FILM
R 509	5322 116 50558	18,7K	1	MR25	METAL FILM
R 511	5322 116 54562	1,4K	1	MR25	METAL FILM
R 512	5322 116 50523	4,99K	1	MR25	METAL FILM
R 513	5322 116 50679	237	1	MR25	METAL FILM
R 514	5322 116 50479	15,4K	1	MR25	METAL FILM
R 515	5322 116 50415	1,15K	1	MR25	METAL FILM
R 517	5322 116 50484	4,64K	1	MR25	METAL FILM
R 518	5322 116 54442	51,1	1	MR25	METAL FILM
R 519	5322 116 54011	5,62K	1	MR25	METAL FILM
R 521	5322 116 50671	2,61K	1	MR25	METAL FILM
R 522	5322 116 50479	15,4K	1	MR25	METAL FILM
R 523	5322 116 50479	15,4K	1	MR25	METAL FILM
R 524	5322 116 54643	20,5K	1	MR25	METAL FILM
R 526	5322 116 50481	22,6K	1	MR25	METAL FILM
R 527	5322 100 10114	4,7K	20	0.5W	TRIMMING POTM
R 528	5322 116 54442	51,1	1	MR25	METAL FILM
R 529	5322 116 54655	30,1K	1	MR25	METAL FILM
R 531	5322 116 54011	5,62K	1	MR25	METAL FILM
R 532	5322 116 54619	10K	1	MR25	METAL FILM
R 533	5322 116 54529	619	1	MR25	METAL FILM
R 534	5322 116 50558	18,7K	1	MR25	METAL FILM
R 536	5322 116 54676	56,2K	1	MR25	METAL FILM
R 537	5322 116 50523	4,99K	1	MR25	METAL FILM
R 576	5322 116 55211	909K	0,5	MR30	METAL FILM
R 577	5322 116 55207	464K	0,5	MR25	METAL FILM
R 578	5322 116 55292	232K	0,5	MR25	METAL FILM
R 579	5322 116 55298	90,9K	0,5	MR25	METAL FILM
R 581	5322 116 55295	45,3K	0,5	MR25	METAL FILM
R 582	5322 116 55291	22,6K	0,5	MR25	METAL FILM
R 583	5322 116 55297	8,87K	0,5	MR25	METAL FILM
R 584	5322 116 55294	4,32K	0,5	MR25	METAL FILM
R 586	5322 116 55288	2K	0,5	MR25	METAL FILM
R 601	5322 116 50593	16,2K	1	MR25	METAL FILM
R 602	5322 116 54619	10K	1	MR25	METAL FILM
R 603	5322 116 54595	5,11K	1	MR25	METAL FILM
R 604	5322 116 54011	5,62K	1	MR25	METAL FILM
R 605	5322 116 50556	4,42K	1	MR25	METAL FILM
R 606	5322 116 50579	3,16K	1	MR25	METAL FILM
R 607	5322 116 54606	7,15K	1	MR25	METAL FILM
R 608	5322 116 50479	15,4K	1	MR25	METAL FILM
R 609	5322 116 50671	2,61K	1	MR25	METAL FILM
R 610	5322 116 54696	100K	1	MR25	METAL FILM
R 611	5322 116 54619	10K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 612	5322 116 54442	51,1	1	MR25	METAL FILM
R 613	5322 116 50414	2,87K	1	MR25	METAL FILM
R 614	5322 116 50558	18,7K	1	MR25	METAL FILM
R 616	5322 116 54442	51,1	1	MR25	METAL FILM
R 617	5322 116 54648	24,9K	1	MR25	METAL FILM
R 618	5322 116 55289	2,26K	0,5	MR25	METAL FILM
R 619	5322 116 55289	2,26K	0,5	MR25	METAL FILM
R 621	5322 116 55286	1,05K	0,5	MR25	METAL FILM
R 622	5322 116 54694	90,9K	1	MR25	METAL FILM
R 624	5322 116 50414	2,87K	1	MR25	METAL FILM
R 626	5322 116 54525	511	1	MR25	METAL FILM
R 627	5322 116 54694	90,9K	1	MR25	METAL FILM
R 628	5322 116 54005	3,32K	1	MR25	METAL FILM
R 629	5322 116 54005	3,32K	1	MR25	METAL FILM
R 631	5322 116 54694	90,9K	1	MR25	METAL FILM
R 633	5322 116 50414	2,87K	1	MR25	METAL FILM
R 634	5322 116 54694	90,9K	1	MR25	METAL FILM
R 636	5322 116 54525	511	1	MR25	METAL FILM
R 637	5322 116 54665	40,2K	1	MR25	METAL FILM
R 638	5322 116 54743	301K	1	MR25	METAL FILM
R 639	5322 116 50414	2,87K	1	MR25	METAL FILM
R 701	5322 116 54525	511	1	MR25	METAL FILM
R 702	5322 116 54558	8,25K	1	MR25	METAL FILM
R 703	5322 116 54683	68,1K	1	MR25	METAL FILM
R 704	5322 116 54665	40,2K	1	MR25	METAL FILM
R 706	5322 116 50442	48,7K	1	MR25	METAL FILM
R 707	5322 116 54619	10K	1	MR25	METAL FILM
R 708	5322 101 14067	4,7K	20	0.5W	TRIMMING POTM
R 709	5322 116 54558	8,25K	1	MR25	METAL FILM
R 712	5322 116 54011	5,62K	1	MR25	METAL FILM
R 713	5322 116 54627	13,3K	1	MR25	METAL FILM
R 714	5322 116 50479	15,4K	1	MR25	METAL FILM
R 717	5322 116 54504	274	1	MR25	METAL FILM
R 718	5322 116 54665	40,2K	1	MR25	METAL FILM
R 719	5322 116 55283	402K	1	MR25	METAL FILM
R 721	5322 116 55284	681K	1	MR25	METAL FILM
R 722	4822 110 42196	2,2M	5	VR37	CARBON
R 723	4822 110 42205	4,7M	5	VR37	CARBON
R 724	4822 110 42214	10M	5	VR37	CARBON
R 725	5322 116 54525	511	1	MR25	METAL FILM
R 726	5322 116 54676	56,2K	1	MR25	METAL FILM
R 727	5322 100 10116	100K	20	0.5W	TRIMMING POTM
R 728	5322 116 54676	56,2K	1	MR25	METAL FILM
R 801	5322 116 54743	301K	1	MR25	METAL FILM
R 802	5322 116 50442	48,7K	1	MR25	METAL FILM
R 803	5322 116 54112	6,49	1	MR25	METAL FILM
R 804	5322 116 54112	6,49	1	MR25	METAL FILM
R 806	5322 116 54619	10K	1	MR25	METAL FILM
R 807	5322 116 54112	6,49	1	MR25	METAL FILM
R 808	5322 116 54112	6,49	1	MR25	METAL FILM
R 809	5322 116 54558	8,25K	1	MR25	METAL FILM
R 811	5322 116 54541	825	1	MR25	METAL FILM
R 812	5322 116 50675	2,26K	1	MR25	METAL FILM
R 813	5322 116 50484	4,64K	1	MR25	METAL FILM
R 814	5322 116 54619	10K	1	MR25	METAL FILM
R 816	5322 116 54655	30,1K	1	MR25	METAL FILM
R 817	5322 116 50679	237	1	MR25	METAL FILM
R 821	5322 116 54469	100	1	MR25	METAL FILM
R 822	5322 116 50904	30,1	1	MR25	METAL FILM
R 823	5322 116 54469	100	1	MR25	METAL FILM
R 824	5322 116 50904	30,1	1	MR25	METAL FILM
R 826	5322 116 50568	4,99	1	MR25	METAL FILM
R 827	5322 116 54442	51,1	1	MR25	METAL FILM
R 828	5322 116 50568	4,99	1	MR25	METAL FILM
R 829	5322 116 54469	100	1	MR25	METAL FILM
R 831	5322 116 54469	100	1	MR25	METAL FILM
R 832	5322 116 50678	20,5	1	MR25	METAL FILM
R 833	5322 116 50568	4,99	1	MR25	METAL FILM
R 834	5322 116 50452	10	1	MR25	METAL FILM
R 836	5322 116 50568	4,99	1	MR25	METAL FILM

SEMI CONDUCTORS

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION	
V 1	5322 131 24048	D14-260GH	
V 101	4822 130 30613	BAW62	
V 102	4822 130 30613	BAW62	
V 103	5322 130 34297	BZX79-C10	
V 104	5322 130 34297	BZX79-C10	
V 201	5322 130 34037	BAV45	
V 202	5322 130 44643	ON561	
V 203	4822 130 44196	BC548C	
V 208	5322 130 34049	BZX75-C2V1	
V 209	4822 130 44197	BC558B	
V 211	4822 130 44196	BC548C	
V 212	4822 130 44197	BC558B	
V 213	4822 130 30613	BAW62	
V 214	4822 130 30613	BAW62	
V 216	4822 130 30613	BAW62	
V 217	4822 130 30613	BAW62	
V 218	4822 130 30613	BAW62	
V 219	4822 130 44196	BC548C	
V 221	4822 130 44196	BC548C	
V 266	4822 130 44196	BC548C	
V 267	4822 130 44154	BF199	
V 268	4822 130 44154	BF199	
V 269	4822 130 34167	BZX79-B6V2	
V 270	5322 130 44237	BF450	
V 271	5322 130 44237	BF450	
V 272	5322 130 44237	BF450	
V 273	5322 130 44237	BF450	
V 274	5322 130 44237	BF450	
V 275	5322 130 44237	BF450	
V 276	5322 130 44237	BF450	
V 277	5322 130 44237	BF450	
V 278	4822 130 44196	BC548C	
V 279	4822 130 44196	BC548C	
V 281	5322 130 34047	BZX75-C1V4	
V 282	5322 130 34047	BZX75-C1V4	
V 301	5322 130 34037	BAV45	
V 302	5322 130 44643	ON561	
V 303	4822 130 44196	BC548C	
V 304	4822 130 44197	BC558B	
V 306	4822 130 44196	BC548C	
V 307	4822 130 44196	BC548C	
V 309	4822 130 44197	BC558B	
V 311	4822 130 44196	BC548C	
V 312	4822 130 44197	BC558B	
V 313	4822 130 30613	BAW62	
V 314	4822 130 30613	BAW62	
V 316	4822 130 30613	BAW62	
V 317	4822 130 30613	BAW62	
V 318	4822 130 30613	BAW62	
V 319	4822 130 44196	BC548C	
V 321	4822 130 44196	BC548C	
V 401	5322 130 34119	BZX79-C8V2	
V 402	4822 130 30613	BAW62	
V 403	4822 130 44197	BC558B	
V 404	4822 130 44197	BC558B	
V 406	4822 130 30613	BAW62	
V 407	4822 130 30613	BAW62	
V 451	4822 130 44154	BF199	
V 452	4822 130 30613	BAW62	
V 453	4822 130 30613	BAW62	
V 454	4822 130 30613	BAW62	
V 456	4822 130 30613	BAW62	
V 457	4822 130 44154	BF199	
V 458	4822 130 44196	BC548C	
V 459	4822 130 44196	BC548C	
V 461	4822 130 44196	BC548C	
V 464	4822 130 30613	BAW62	
V 466	4822 130 30229	AAZ15	
V 467	4822 130 44196	BC548C	
V 468	4822 130 30613	BAW62	
V 469	4822 130 44196	BC548C	
V 471	4822 130 30861	BZX79B7V5	
V 472	5322 130 44237	BF450	
V 473	4822 130 30613	BAW62	
V 474	4822 130 44196	BC548C	
V 476	5322 130 44237	BF450	
V 491	4822 130 44196	BC548C	
V 492	4822 130 44196	BC548C	
V 493	4822 130 30613	BAW62	
V 494	4822 130 30613	BAW62	
V 495	4822 130 30613	BAW62	
V 496	4822 130 44197	BC558B	
V 500	4822 130 30613	BAW62	
V 501	4822 130 44196	BC548C	
V 502	4822 130 44197	BC558B	
V 503	4822 130 44196	BC548C	
V 504	5322 130 40417	BSX20	
V 506	4822 130 44196	BC548C	
V 507	4822 130 44196	BC548C	
V 508	4822 130 44196	BC548C	
V 509	4822 130 30613	BAW62	
V 511	4822 130 44196	BC548C	
V 512	4822 130 44196	BC548C	
V 513	4822 130 30613	BAW62	
V 514	4822 130 30613	BAW62	
V 516	4822 130 30613	BAW62	
V 517	4822 130 30613	BAW62	
V 602	4822 130 44197	BC558B	
V 603	4822 130 30613	BAW62	
V 604	4822 130 30613	BAW62	
V 605	4822 130 30613	BAW62	
V 606	4822 130 30613	BAW62	
V 607	4822 130 30613	BAW62	
V 608	4822 130 41084	BF422	PH
V 609	4822 130 44196	BC548C	
V 611	4822 130 41084	BF422	PH
V 612	4822 130 41106	BF423	PH
V 613	4822 130 41106	BF423	PH
V 614	4822 130 44197	BC558B	
V 616	4822 130 34167	BZX79-B6V2	
V 617	4822 130 44197	BC558B	
V 618	4822 130 41106	BF423	PH
V 619	4822 130 41106	BF423	PH
V 621	5322 130 34047	BZX75-C1V4	
V 622	5322 130 34047	BZX75-C1V4	
V 701	4822 130 44257	BC547	
V 702	5322 130 44247	BSS68	
V 703	4822 130 30613	BAW62	
V 704	5322 130 34605	BAX12A	
V 706	4822 130 30842	BAV21	
V 707	4822 130 30613	BAW62	
V 708	4822 130 44257	BC547	
V 709	4822 130 44257	BC547	
V 710	5322 130 34047	BZX75-C1V4	
V 711	4822 130 44196	BC548C	
V 712	4822 130 44197	BC558B	
V 801	5322 130 34605	BAX12A	
V 802	5322 130 34594	BY409-A	
V 803	5322 130 34594	BY409-A	
V 804	5322 130 34594	BY409-A	
V 806	5322 130 34594	BY409-A	
V 807	5322 130 34605	BAX12A	
V 808	5322 130 34605	BAX12A	
V 809	5322 130 34605	BAX12A	
V 811	4822 130 30613	BAW62	
V 812	4822 130 30613	BAW62	
V 813	4822 130 30613	BAW62	
V 814	4822 130 30613	BAW62	
V 816	4822 130 30839	BY206	
V 817	4822 130 30839	BY206	
V 818	4822 130 44235	BD237	
V 819	4822 130 44235	BD237	
V 821	4822 130 30613	BAW62	
V 822	4822 130 44196	BC548C	
V 823	4822 130 44256	BC557	
V 824	5322 130 30765	BZX75-C3V6	
V 826	4822 130 30613	BAW62	
V 827	4822 130 34233	BZX79-B5V1	
V 828	4822 130 30414	BY164	

MISCELLANEOUS

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
B 1	5322 130 34595	
F 801	4822 253 20014	
K 601	5322 280 24103	SAM REED RELAIS
L 801	5322 281 64154	COIL
L 802	5322 281 64154	COIL
L 803	5322 281 64154	COIL

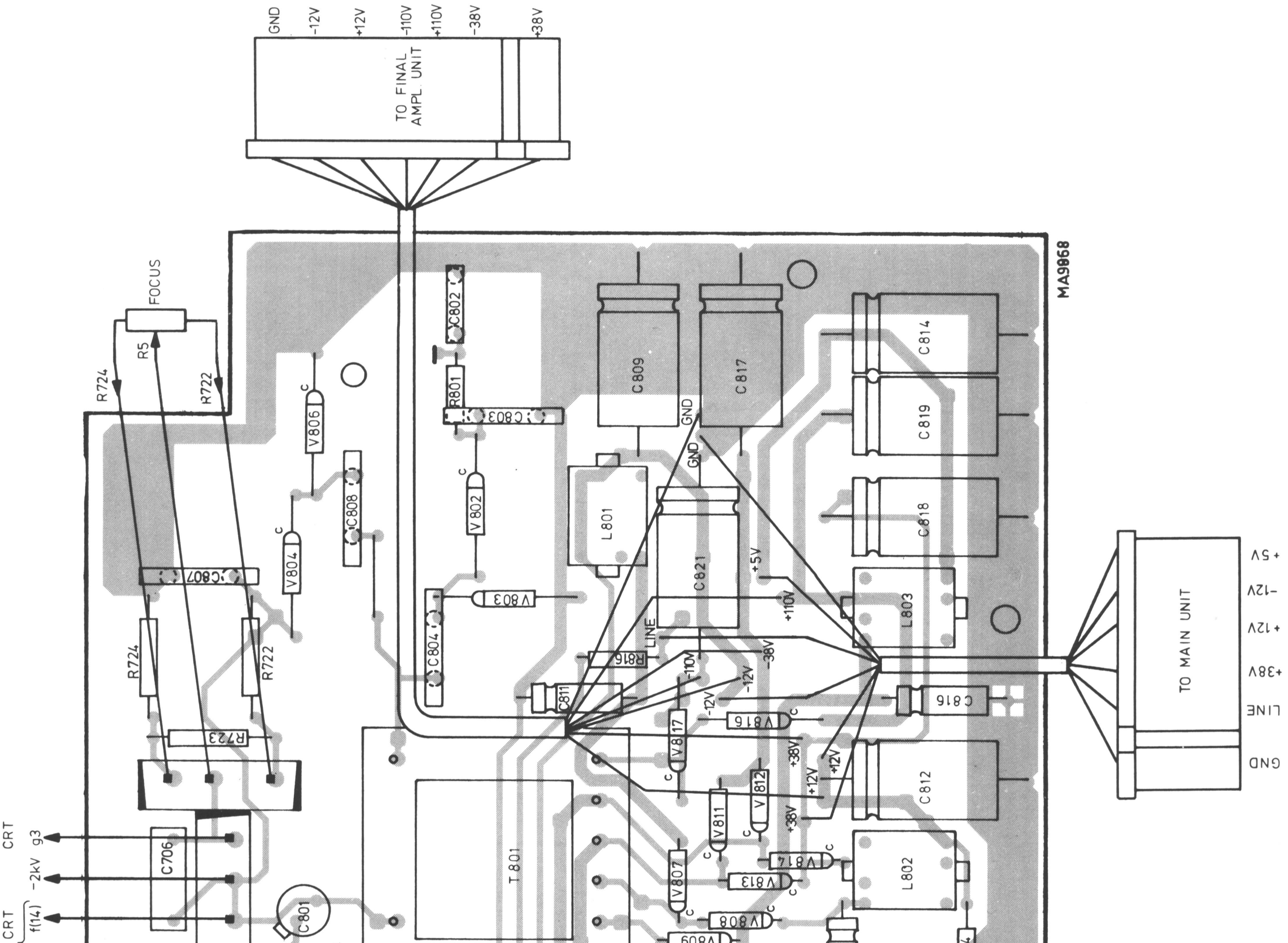


Fig. 3.15. Power supply unit, components lay-out

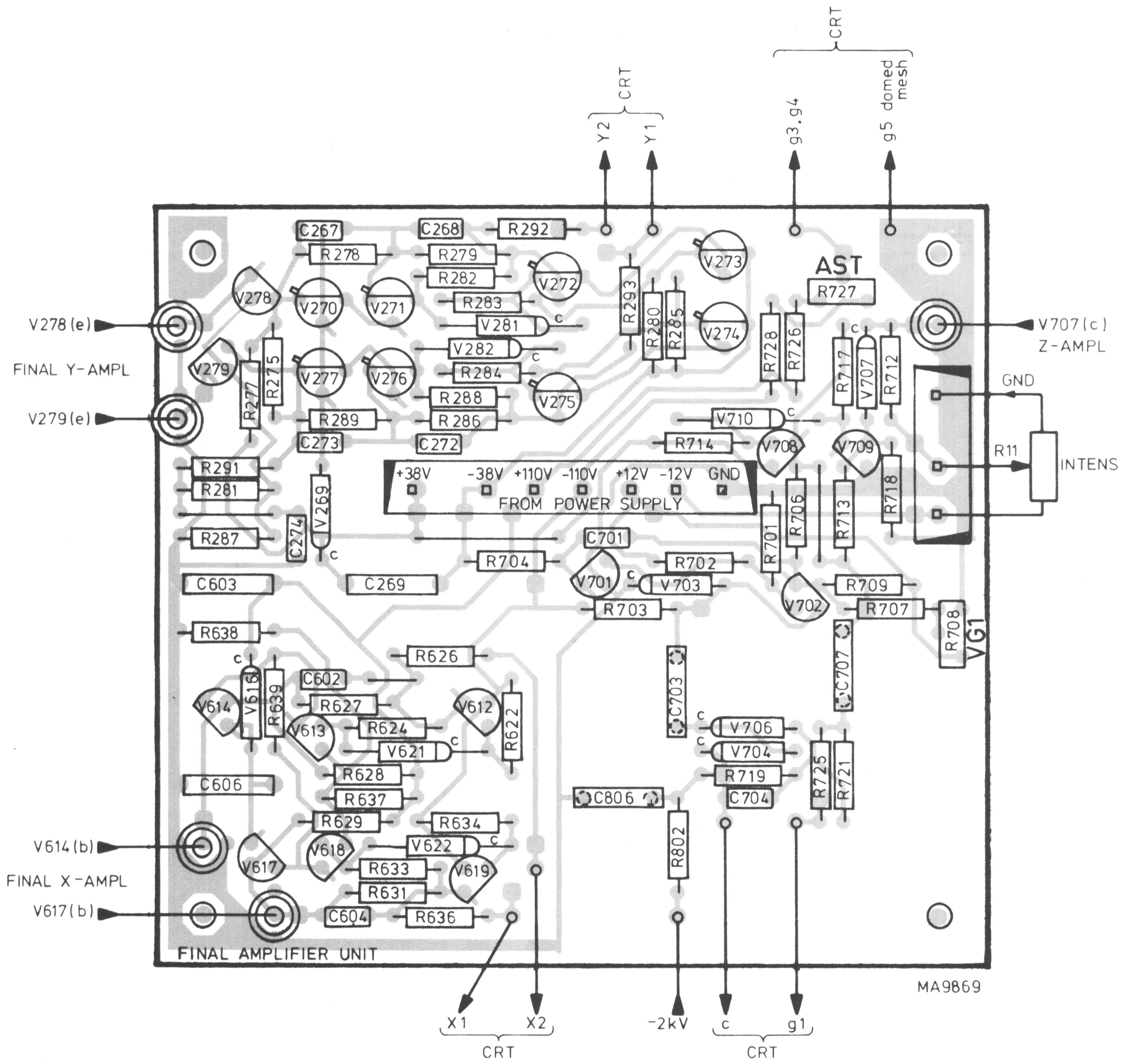


Fig. 3.16. Final amplifier unit, components lay-out

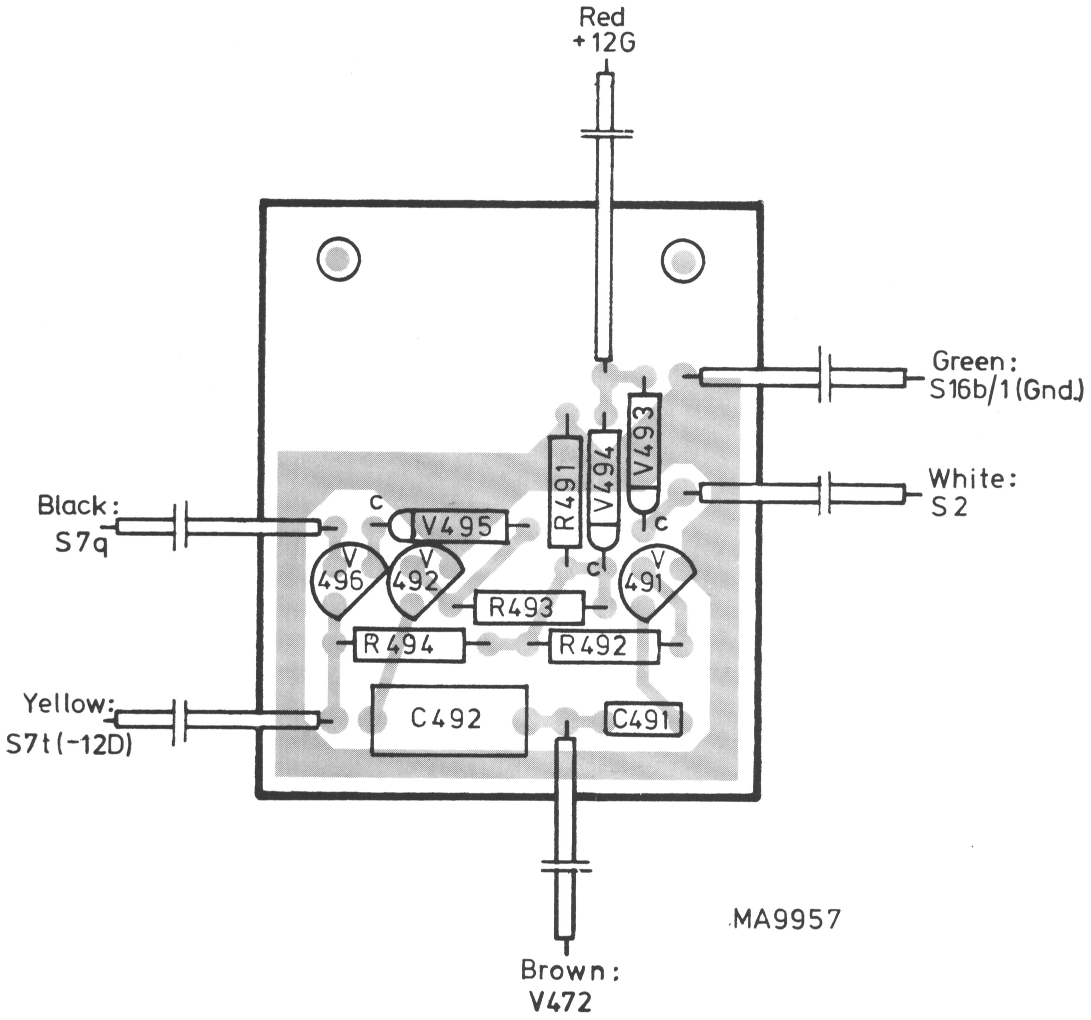
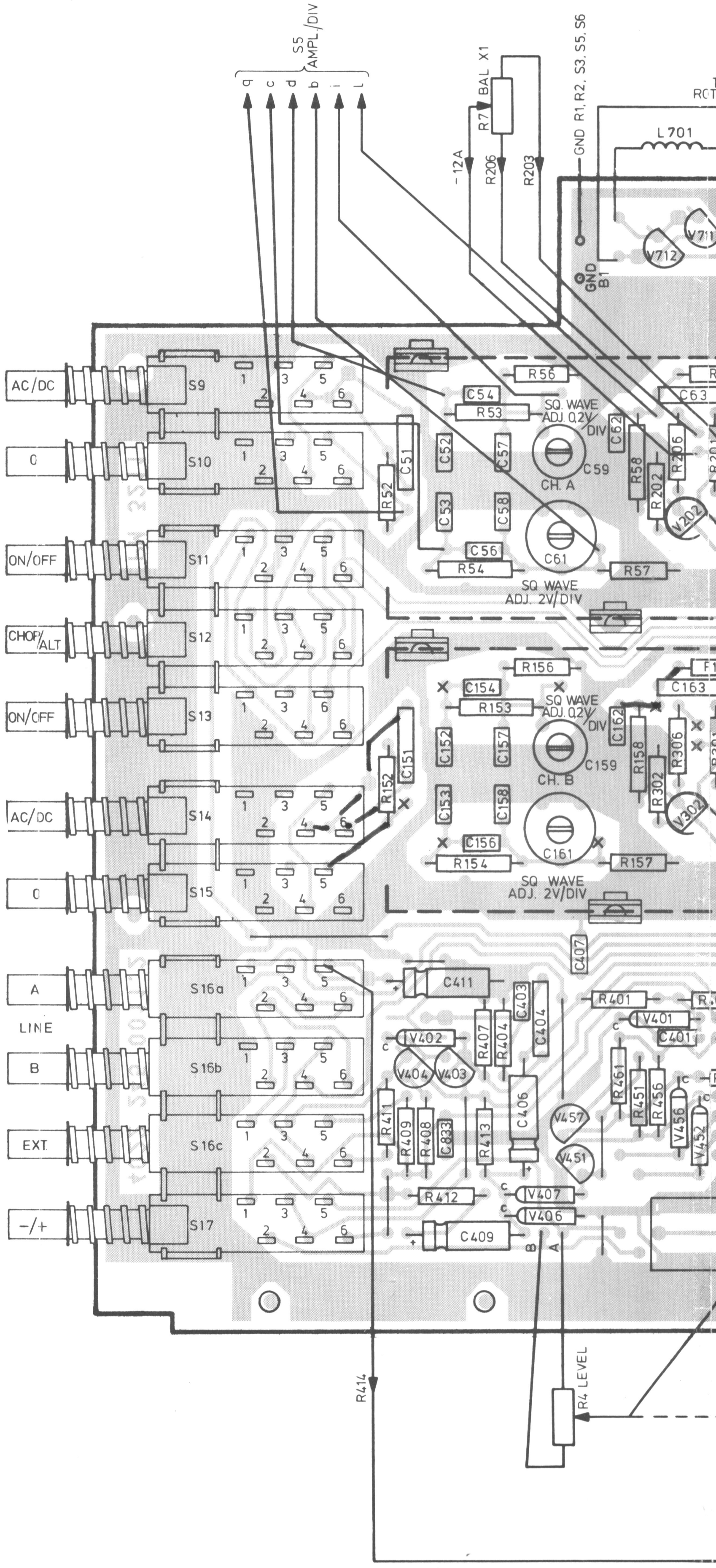


Fig. 3.17. TV trigger unit, components lay-out



X= As for as CH A and CH. B are identical only the wiring of CH. A is indicated

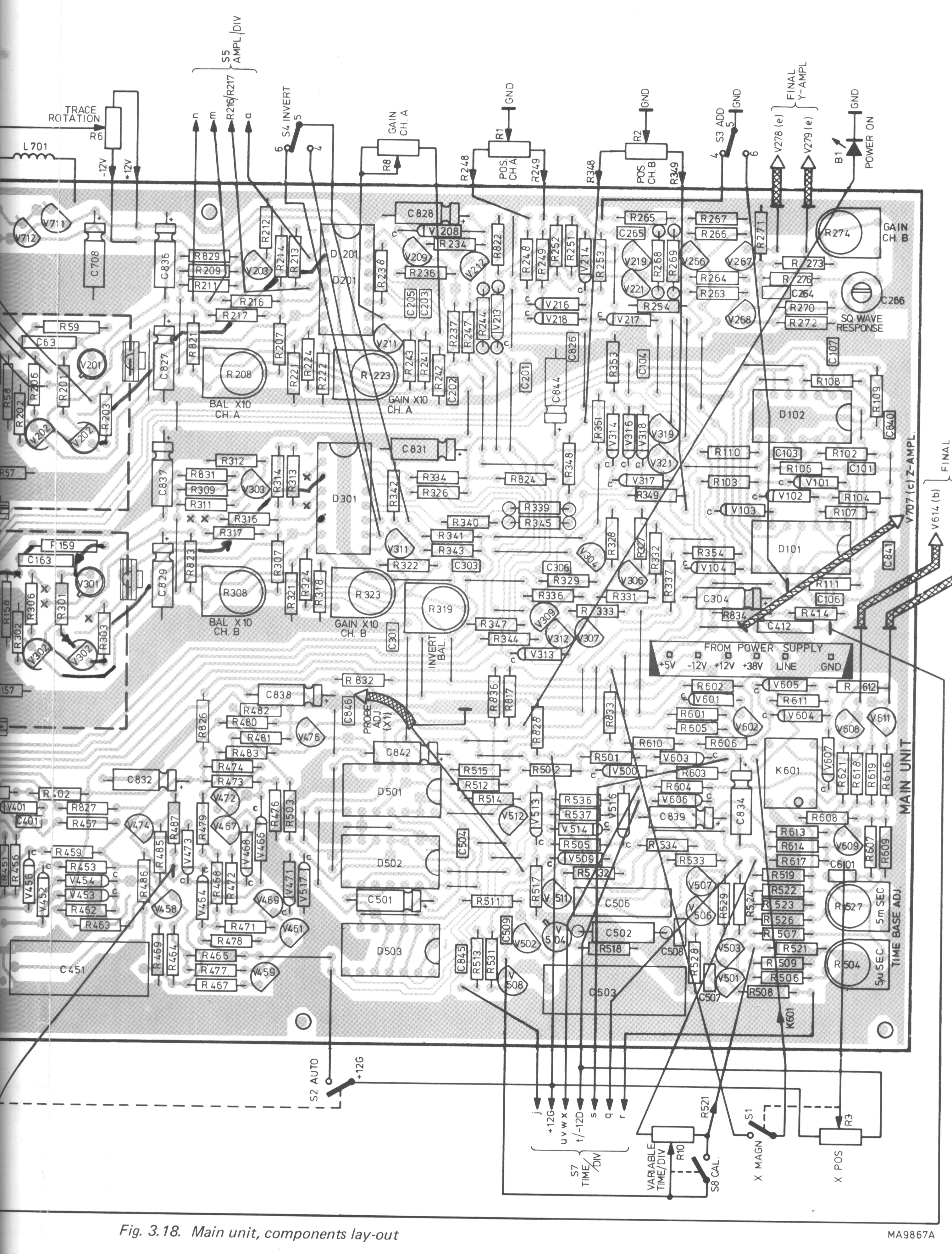
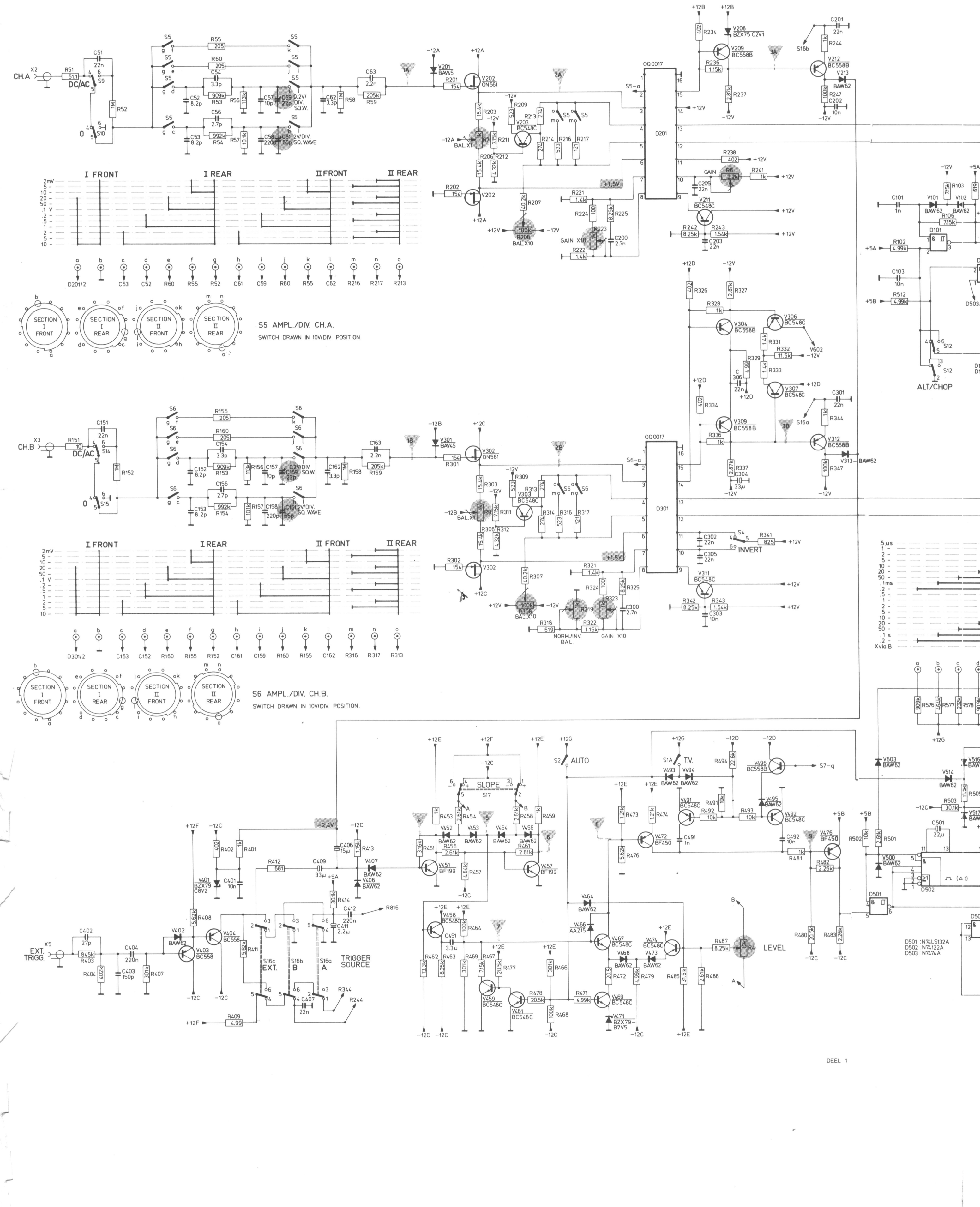
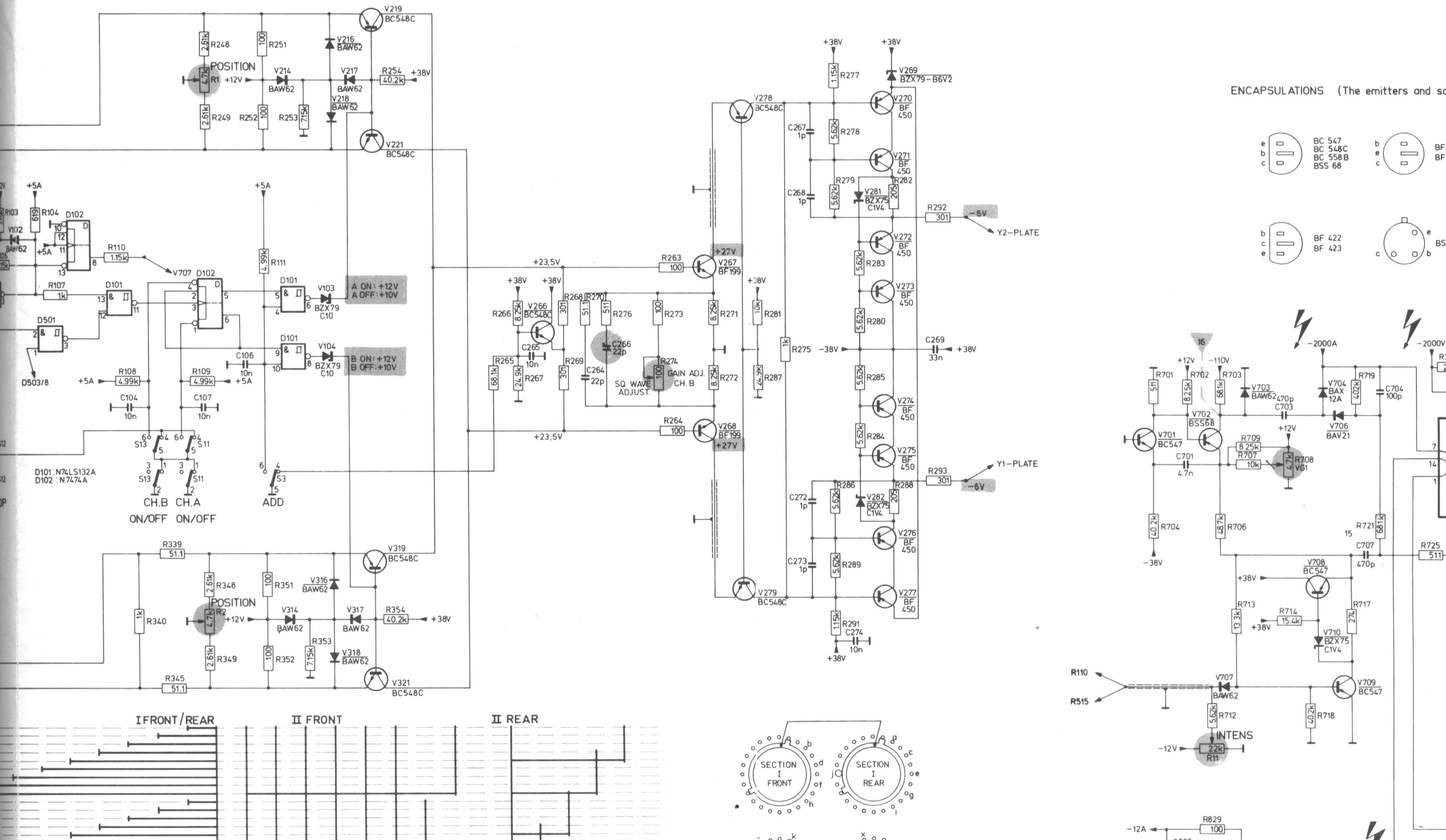


Fig. 3.18. Main unit, components lay-out

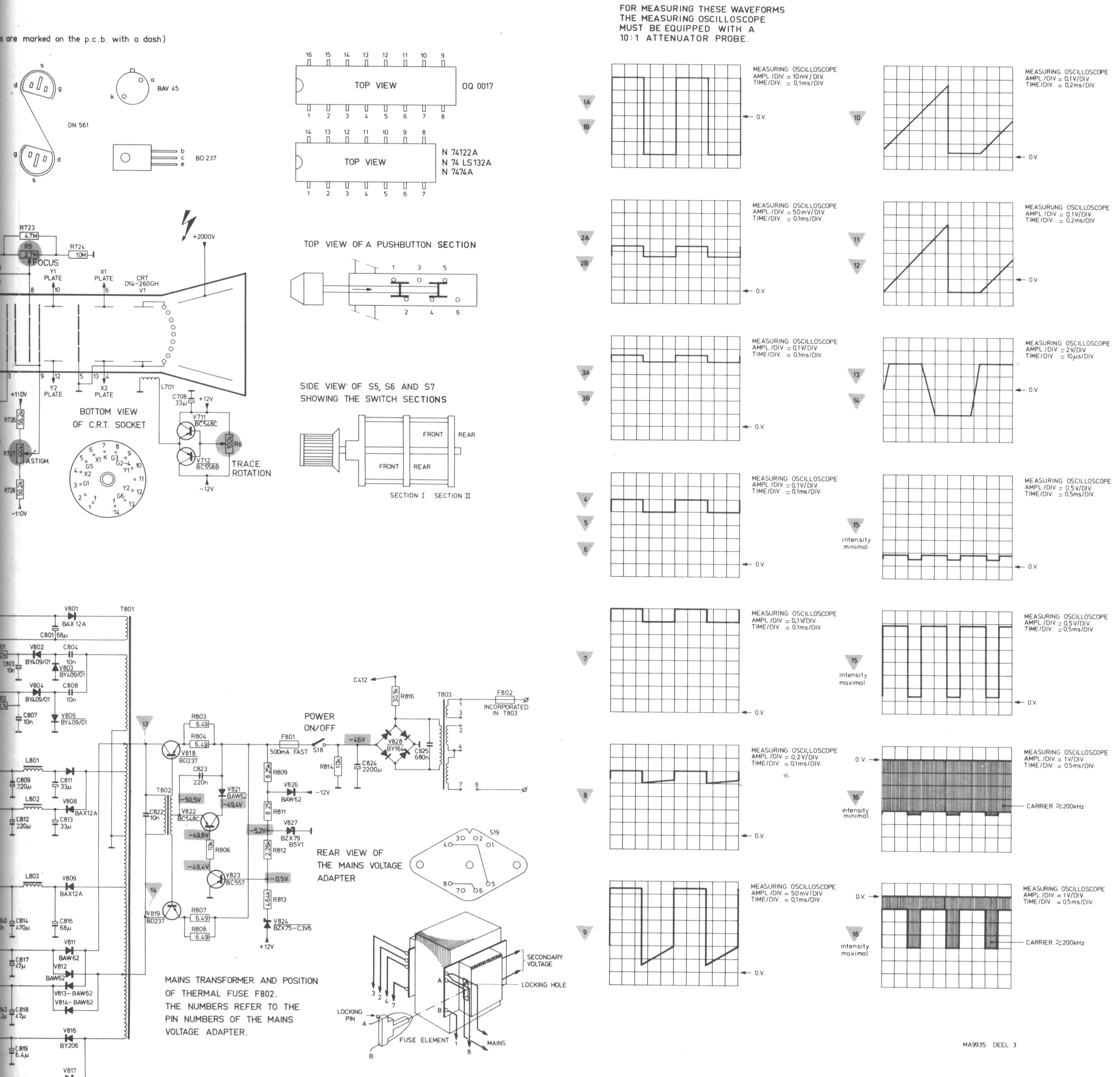
MA9867A


CH.A
X2
DC/AC
S9
S10
S5 AMPL./DIV. CH.A.
SWITCH DRAWN IN 10V/DIV. POSITION.
I FRONT
I REAR
II FRONT
II REAR
SECTION I FRONT
SECTION I REAR
SECTION II FRONT
SECTION II REAR
0.2V/DIV. SQ.W.
2V/DIV. SQ.WAVE
BAL. X1
BAL. X10
GAIN X10
GAIN
OQ0017
D201
D301
BZX75 C2V1
ALT/CHOP
CH.B
X3
DC/AC
S14
S15
S6 AMPL./DIV. CH.B.
SWITCH DRAWN IN 10V/DIV. POSITION.
NORM./INV. BAL.
INVERT
EXT. TRIGG.
X5
TRIGGER SOURCE
S16c EXT.
S16b B
S16a A
SLOPE
S17
S2 AUTO
S1A T.V.
LEVEL
D501 : N74LS132A
D502 : N74122A
D503 : N7474A

DEEL 1


ENCAPSULATIONS (The emitters and sc
BC 547
BC 548C
BC 558B
BSS 68
BF 422
BF 423
POSITION
R1
POSITION
R2
A ON: +12V
A OFF: +10V
B ON: +12V
B OFF: +10V
D101: N74LS132A
D102: N74 74A
CH.B CH.A
ON/OFF ON/OFF
ADD
SQ. WAVE ADJUST.
GAIN ADJ. CH. B
Y2-PLATE
Y1-PLATE
-6V
+27V
+23,5V
I FRONT/REAR
II FRONT
II REAR
SECTION I FRONT
SECTION I REAR
SECTION II FRONT
SECTION II REAR
S7 TIME/DIV.
SWITCH DRAWN IN X VIA B POSITION
5µs/DIV ADJUST.
VARIABLE TIME/DIV.
CAL.
5ms/DIV ADJUST.
PROBE ADJUST
X POSITION
XMAGN
X2-PLATE
X1-PLATE
+103V
-7V
INTENS
R11
R110
R515
-2000V
+2000V
-2000A
POWER ON
CQY24/A B1
-12,6V
+12,3V
+5,2V
-39V
+38,5V
+110,5V
-110V

DEEL 2



s are marked on the p.c.b. with a dash)

FOR MEASURING THESE WAVEFORMS THE MEASURING OSCILLOSCOPE MUST BE EQUIPPED WITH A 10:1 ATTENUATOR PROBE.

MAINS TRANSFORMER AND POSITION OF THERMAL FUSE F802. THE NUMBERS REFER TO THE PIN NUMBERS OF THE MAINS VOLTAGE ADAPTER.

ON 561
BAV 45
BD 237
TOP VIEW
OQ 0017
TOP VIEW
N 74122A
N 74 LS132A
N 7474A
TOP VIEW OF A PUSHBUTTON SECTION
SIDE VIEW OF S5, S6 AND S7 SHOWING THE SWITCH SECTIONS
FRONT
REAR
SECTION I
SECTION II
R723 4.7M
R5 2.7M
FOCUS
R724 10M
+2000V
Y1 PLATE
X1 PLATE
CRT D14-260GH V1
Y2 PLATE
X2 PLATE
L701
C708 33μ
+12V
V711 BC548C
V712 BC558B
R6 100k
TRACE ROTATION
-12V
+110V
R726 56.2k
R727
ASTIGM.
R728 56.2k
-110V
BOTTOM VIEW OF C.R.T. SOCKET
V801 BAX12A
T801
C801 68μ
V802 BY409/01
C804 10n
V803 BY409/01
V804 BY409/01
C808 10n
C807 10n
V806 BY409/01
L801
C809 220μ
C811 33μ
L802
V808 BAX12A
C812 220μ
C813 33μ
L803
V809 BAX12A
C814 470μ
C816 68μ
V811 BAW62
C817 47μ
V812 BAW62
V813-BAW62
V814-BAW62
C818 47μ
V816 BY206
C819 6.4μ
V817 BY206
C821 6.4μ
13
14
R803 6.49
R804 6.49
V818 BD237
C823 220n
T802
C822 10n
-50,5V
V821 BAW62
-49,4V
V822 BC548C
-49,8V
R806 10k
-49,4V
V823 BC557
-0,5V
V819 BD237
R807 6.49
R808 6.49
R809 8.25k
V826 BAW62
-12V
R811 8.25k
-5,2V
V827 BZX79 B5V1
R812 2.74k
R813 4.64k
V824 BZX75-C3V6
+12V
C412
R816 30.1k
POWER ON/OFF
F801 500mA FAST
S18
-46V
V828 BY164
C825 680n
R814 10k
C824 2200μ
T803
F802 INCORPORATED IN T803
REAR VIEW OF THE MAINS VOLTAGE ADAPTER
S19
SECONDARY VOLTAGE
LOCKING HOLE
LOCKING PIN
FUSE ELEMENT
MAINS
1A
1B
MEASURING OSCILLOSCOPE AMPL./DIV. = 10mV/DIV. TIME/DIV. = 0,1ms/DIV.
2A
2B
MEASURING OSCILLOSCOPE AMPL./DIV. = 50mV/DIV. TIME/DIV. = 0,1ms/DIV.
3A
3B
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,1V/DIV. TIME/DIV. = 0,1ms/DIV.
4
5
6
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,1V/DIV. TIME/DIV. = 0,1ms/DIV.
7
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,1V/DIV. TIME/DIV. = 0,1ms/DIV.
8
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,2V/DIV. TIME/DIV. = 0,1ms/DIV.
9
MEASURING OSCILLOSCOPE AMPL./DIV. = 50mV/DIV. TIME/DIV. = 0,1ms/DIV.
10
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,1V/DIV. TIME/DIV. = 0,2ms/DIV.
11
12
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,1V/DIV. TIME/DIV. = 0,2ms/DIV.
13
14
MEASURING OSCILLOSCOPE AMPL./DIV. = 2V/DIV. TIME/DIV. = 10μs/DIV.
15 intensity minimal
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,5V/DIV. TIME/DIV. = 0,5ms/DIV.
15 intensity maximal
MEASURING OSCILLOSCOPE AMPL./DIV. = 0,5V/DIV. TIME/DIV. = 0,5ms/DIV.
16 intensity minimal
MEASURING OSCILLOSCOPE AMPL./DIV. = 1V/DIV. TIME/DIV. = 0,5ms/DIV.
CARRIER ≈200kHz
16 intensity maximal
MEASURING OSCILLOSCOPE AMPL./DIV. = 1V/DIV. TIME/DIV. = 0,5ms/DIV.
CARRIER ≈200kHz
0.V.
MA9935 DEEL 3

Fig. 3.19. PM 3211/PM 3211Q circuit diagram

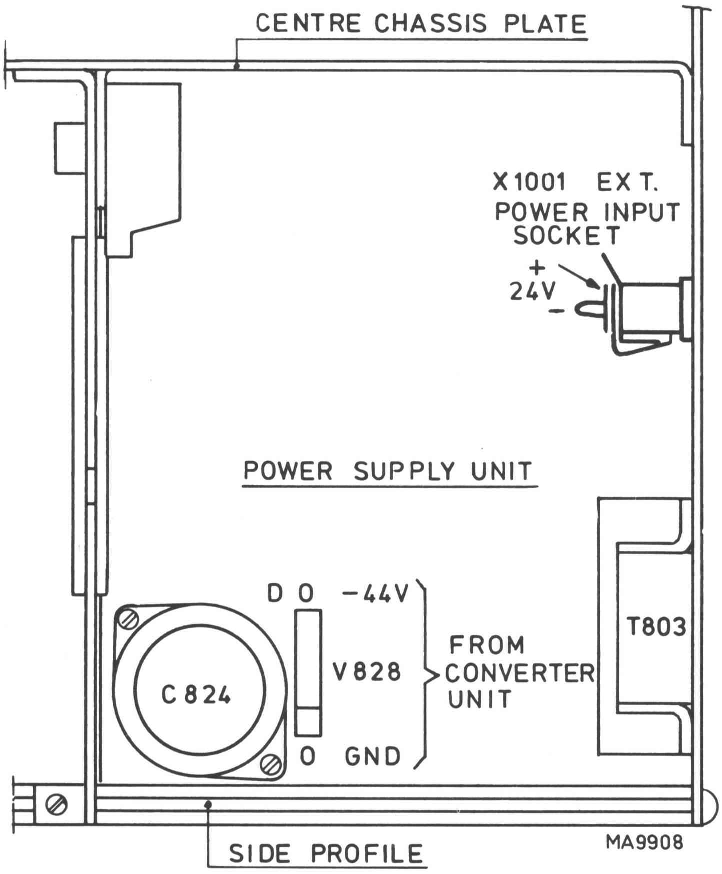


Fig. 3.20. Power supply compartment with connection points for ext. 24 VDC power supply unit

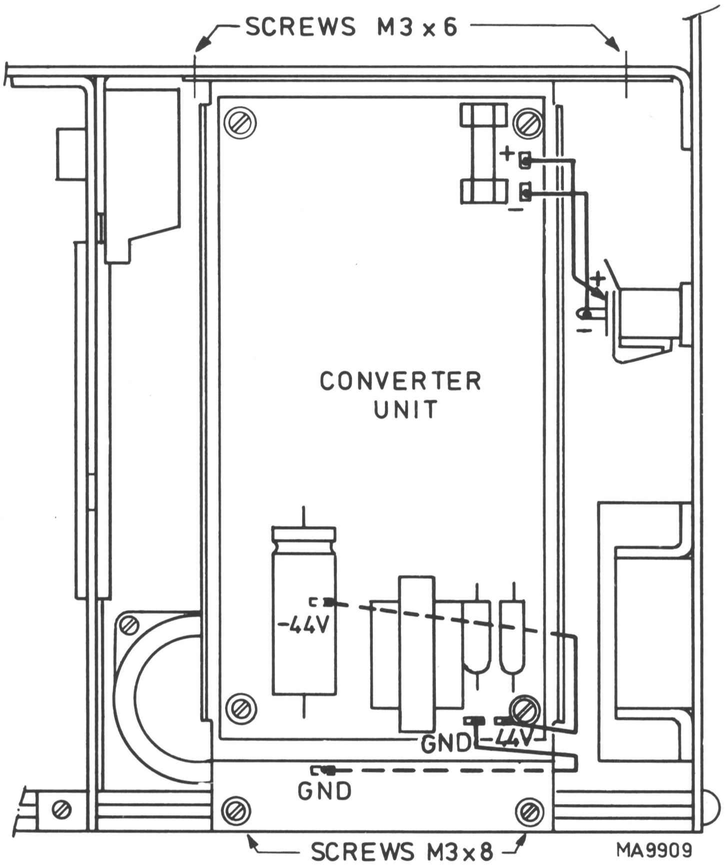


Fig. 3.21. Power supply compartment with ext. 24 VDC power supply unit installed

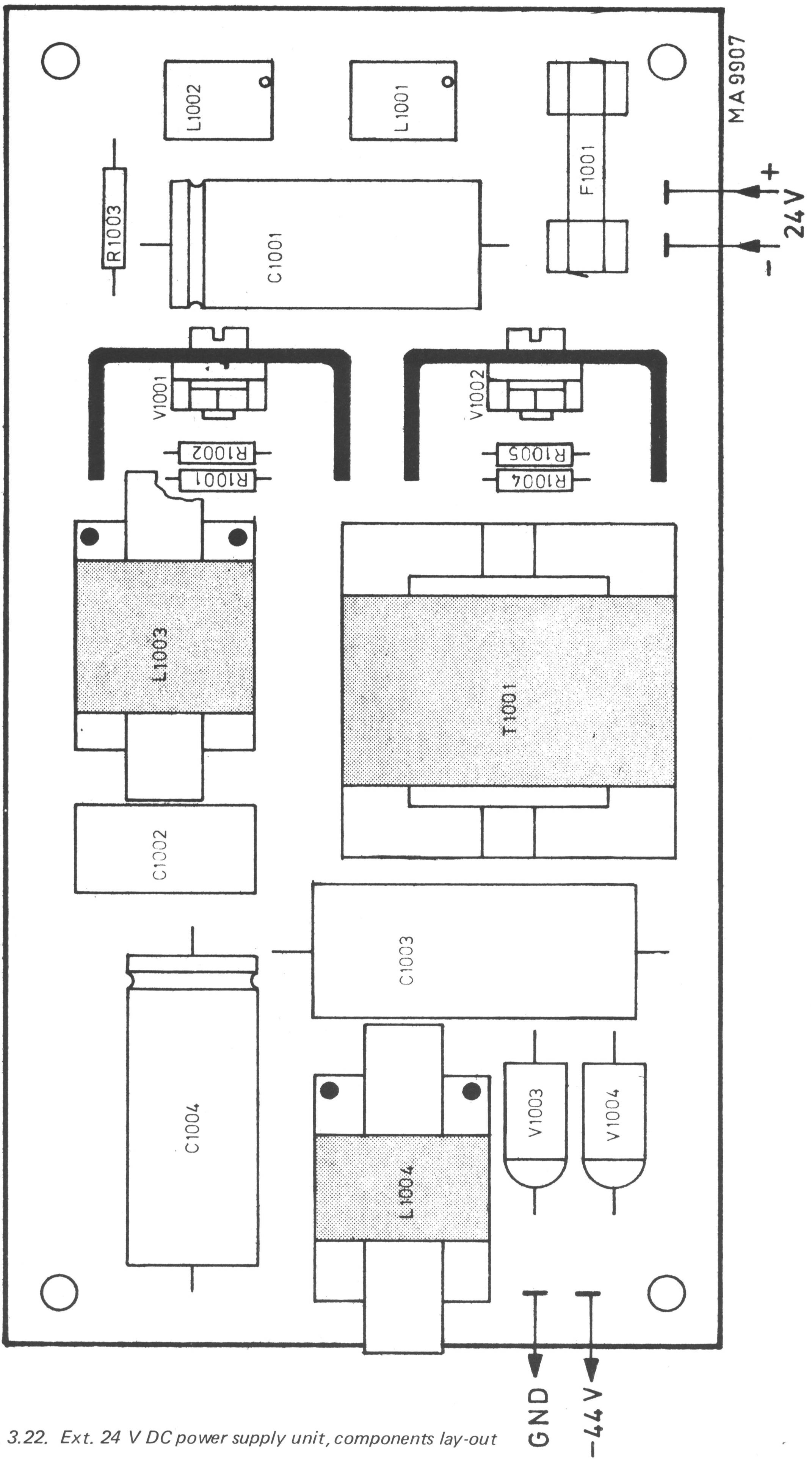


Fig. 3.22. Ext. 24 V DC power supply unit, components lay-out

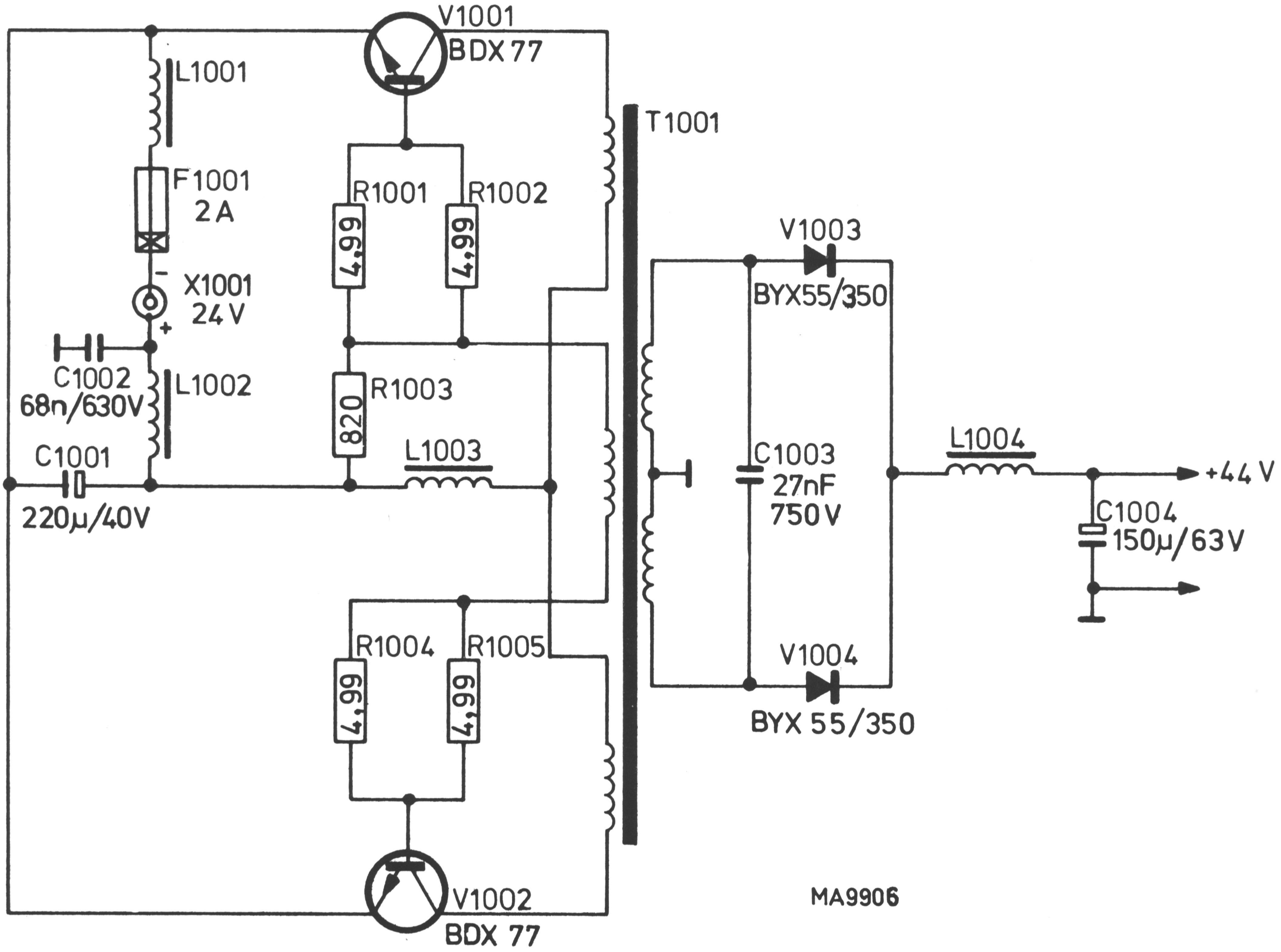


Fig. 3.23. Ext. 24 VDC power supply unit, circuit diagram

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① *Country*	② *Day Month Year*	③ *Typenumber /Version*	④ *Factory/Serial no.*
3 2	1 5 0 4 7 5	O P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ *Nature of call*	*Location*	*Component/sequence no.*	*Category*
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ ☐ ☐ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version O P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box
⑥Coded failure description

Location

☐ ☐ ☐ ☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐ ☐ ☐ ☐ ☐ ☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000	Unknown/Not applicable
990001	Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002	Knob (incl. dial knob, cap, etc.)
990003	Probe (only if attached to instrument)
990004	Leads and associated plugs
990005	Holder (valve, transistor, fuse, board, etc.)
990006	Complete unit (p.w. board, h.t. unit, etc.)
990007	Accessory (only those without type number)
990008	Documentation (manual, supplement, etc.)
990009	Foreign object
990099	Miscellaneous

Category

☐

0	Unknown, not applicable (fault not present, intermittent or disappeared)
1	Software error
2	Readjustment
3	Electrical repair (wiring, solder joint, etc.)
4	Mechanical repair (polishing, filing, remachining, etc.)
5	Replacement (of transistor, resistor, etc.)
6	Cleaning and/or lubrication
7	Operator error
8	Missing items (on pre-sale test)
9	Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.
⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling waiting time, etc.), using the last box for tenths of hours.

☐ ☐ 1 2 = 1,2 working hours (1 h 12 min.)

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